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BUILDERS HANDBOOK

OF NATCO HOLLOW TILE CONSTRUCTION

NATIONAL FIRE-PROOFING
• COMPANY •



PITTSBURGH PENNSYLVANIA





Introduction



THIS volume dealing chiefly with our newly designed exterior wall tile NATCO XXX is a complete and practical text book for the guidance of the builder in every detail for erecting hollow tile.

The methods illustrated and described represent the work as approved by fireproofing engineers and architects, having been determined by wide practical experience in NATCO hollow tile construction.

NATCO XXX hollow tile with its superior qualities of extra heavy shells and webs, all in direct alignment when laid, deep dovetail scoring, which affords the best possible mechanical bond for the stucco, costs no more than the old style of tile.

We will be glad at all times to give information to any interested party, regarding our products or their different uses in the building.

NATIONAL FIRE PROOFING COMPANY

Main Offices: PITTSBURGH, PENNSYLVANIA, Fulton Building

CHICAGO	-	-	-	-	-	Webster Building
NEW YORK	-	-	-	-	-	Flatiron Building
PHILADELPHIA	-	-	-	-	-	Laad Title Building
BOSTON	-	-	-	-	-	John Hancock Building
WASHINGTON, D. C.	-	-	-	-	-	Woodward Building
COLUMBUS	-	-	-	-	-	West Broad Street
CANTON	-	-	-	-	-	City National Bank Building
DETROIT	-	-	-	-	-	Pennobscot Building
MINNEAPOLIS	-	-	-	-	-	Plymouth Building
LOS ANGELES	-	-	-	-	-	Central Building

TORONTO, ONTARIO

Twenty-three Factories in the United States



SPECIFICATION SHEET FOR ERECTING NATCO HOLLOW TILE

GENERAL:—Provide and erect all hollow tile exterior and interior bearing walls of hard burned tile, true and regular in size, manufactured of such design that all webs and shells are in direct compression when laid in the wall. Tile shall have all faces scored with special dovetail scoring to offer a good surface for the stucco finish. Tile cracked or broken on the outside shells will not be acceptable under this specification.

All subdividing, non-bearing partitions shall be of hollow partition tile as shown on plans. In general all exterior walls and interior bearing walls shall be of NATCO XXX hollow tile; subdividing walls shall be NATCO partition tile as manufactured by the National Fire Proofing Company.

LAYING:—All tile used in the exterior walls and interior bearing partitions must be laid with the holes or voids vertical in the wall, in order to develop their full strength. Interior subdividing, non-bearing partition tile may be laid on side if desired. Care must be taken that the top of all unfinished walls are thoroughly covered or protected against stormy weather.

MORTAR:—All mortar used for laying up the hollow tile shall consist of a standard Portland cement and clean sharp sand in the proportion of one part cement to three parts sand, well mixed to a smooth, moderately stiff mortar. Lime not to exceed 10 per cent. of the cement by volume, will be allowed in the mortar.

FOUNDATION WALLS:—Where so indicated on plans, the foundation walls from top of footings to the underside of first floor beams shall be constructed of 9-hole 12 x 12 x 12 NATCO XXX hollow tile. Care should be taken to use 6 x 12 x 12 NATCO XXX hollow tile at the corners. Outside of walls from footing to a point above the ground shall be given a heavy coat of waterproofed cement or other approved damp-proofing.

Where columns or piers supporting heavy loads rest on the foundation wall, the same shall be filled with concrete from footing to top of wall to prevent the possibility of failure due to compression.

EXTERIOR WALLS AND BEARING PARTITIONS:—Exterior walls and bearing partitions shall be of thickness shown on the plans and must be in accordance with the foregoing conditions of quality, etc.

SUBDIVIDING PARTITIONS:—Subdividing, non-bearing partitions shall be of hard burned NATCO hollow tile (scored for plastering). All partitions must be started on the structural floor and wedged against the floor above.

JAMB TILE:—Provide for all double hung windows, NATCO XXX jamb tile with rabbetted openings to receive the window frame box. Fill well with mortar the space between the tile and the frame box to within one inch of stop bead and calk to stop bead with roofers cement or oakum to prevent the passage of air or moisture.

LINTELS:—Openings not exceeding 5'-0" in clear span may be spanned with NATCO XXX arch lintel tile or with NATCO XXX tile reinforced with rods in lower cells and filled solidly with concrete.

Openings over 5'-0" in clear span to be spanned with reinforced concrete girder faced with tile, or with steel angles—size of structural or reinforcing steel variable with load and span.

SILLS:—Form all sills of NATCO special hollow sill tile. Special care must be taken to fill all joints so as to prevent moisture working through the same; wood sill of frame to be set in a heavy bed of roofers cement.

ARCH OPENINGS:—Build all arch openings shown on plans of two course rowlock hollow brick header arches, carefully laid on substantial centers. Arches will spring from the hollow tile and must be well bedded on them.

PORCH COLUMNS AND PIERS:—Construct the porch columns and piers of hollow tile to sizes as shown. Where column finish is round, build the same of three inch circular hollow tile column covering, filling the column with concrete when the second story walls are supported by them. If steel reinforcement is used care should be taken to band the steel against lateral deflection. Square columns shall be built of the proper size NATCO XXX tile.

FLOOR BEAM BEARINGS:—Provide and set terra cotta slabs one inch thick under all floor beams as bearing plates for the same. These slabs shall also be used for working up to levels and story heights when the full or fractional tile do not work out correctly.

BEAM COURSES:—Wood floor beams are to be framed into exterior walls as shown on detail, using NATCO XXX hollow tile in accordance with the following: in eight inch walls 3 x 12 x 12 for facing ends of beams, and 4 x 12 x 12 for filling between beams. In ten inch walls 5 x 12 x 12 for facing ends of beams, and 4 x 12 x 12 for filling between beams. In twelve inch walls 6 x 12 x 12 for facing ends of beams, and 5 x 12 x 12 tile for filling between beams.

ROOF PLATES:—Embed in cement grout in two upper courses of wall at intervals of five feet, $\frac{3}{4}$ inch bolts twenty-four inches long. Bolt to project six inches above the top of the wall to allow of plate being fastened down with nuts.

FLOOR CONSTRUCTION

GENERAL:—Floor construction shall be either of the type known as the combination hollow tile and concrete floor construction, consisting generally of four inch reinforced concrete beams spaced sixteen inches on centers with NATCO hollow tile between, and covered with concrete top as shown, or the "Johnson" system of NATCO tile laid on a one inch bed of one to three cement and sand with metal fabric bedded therein, all to have at least four inch bearing on walls.

CONCRETE:—All concrete used in floor construction shall consist of one part Portland cement, two parts clean sharp sand, and four parts broken stone or gravel of such size as will pass through a three-quarter inch ring. Concrete will be of wet mixture and must be well tamped and worked around reinforcing steel after pouring.

REINFORCING STEEL:—Steel rods for floor construction must be of such type as will have a mechanical bond with the concrete. Corrugated, twisted or similar type will be accepted. Steel must have an elastic limit of not less than one-half the tensile strength. Rods must be clean and free from rust scales before placing in position and must be placed not over one inch above bottom of floor.

TILE:—Depth of NATCO tile and size of steel reinforcement will be regulated by span and load to be carried and will be of size indicated on the plans. All tile must be wet before concrete is placed so as to insure a proper bond with the concrete.

CENTERS:—Centers must be of such size as to insure of their not deflecting under the weight of the wet concrete, and must be provided in such quantity as to insure of speedy work. Centers must not be removed before the concrete has properly set, and under long spans a center line of supports must be maintained for at least three weeks after the concrete has been poured. In cold weather the centers must be left in place until directed by the architect to remove them.

SPECIFICATIONS FOR STUCCO ON HOLLOW TILE

All joints between door frames, window frames at head, sides and sills, must be tightly calked with oakum or roofers cement; also the wash or slope of sills, etc. should be given a heavy coat of waterproofing before stucco is applied.

All stucco should be applied immediately upon being mixed and should not be retempered after it has become partially set. No stucco is to be applied in freezing weather or when it is liable to freeze before it sets. It is advisable to keep all stucco work thoroughly wetted down until cement has set, particularly in hot weather as too rapid drying will cause cracking.

The surface to which scratch coat is applied shall be free from all foreign material and shall be thoroughly wetted down before the first coat is applied. The first coat to be applied with force so as to key behind the dovetail scoring, also to prevent air bubbles or holes, and to be thoroughly scratched to insure proper bond with the next coat. The second coat should be applied as soon as the prior coat has sufficiently set to allow working upon the same, and should be straightened with darby and straight edge, then floated with cork or wooden float to prevent waves showing on the finished wall.

Should it be impossible to apply the second and latter coats as soon as the former coat has become thoroughly set, it is advisable to wet down the coat which has been applied as this gives a better bond between successive layers.

The finish coat should as far as possible, be applied to the entire area of one side of structure at one operation. No finish coat should be left in an unfinished condition. All work should be covered to corners.

Thickness of each coat should average from one-quarter to one-half of an inch. While two coats of stucco, carefully applied, having a total thickness of not less than three-quarters of an inch is allowable for rough cast or pebble dash finish, much better results can be obtained when three coats are applied. Three coats should always be applied when a smooth or float finish is desired.

Finish coat of stucco should be waterproofed with an approved brand of Integral Waterproofing Compound or other approved compound as per directions of manufacturers.

MATERIALS

The materials composing the stucco shall consist of:—

1. Portland cement which has been carefully tested and found to meet the requirements of the American Society for Testing Materials.
2. Sand which is free from organic matter or loam and uniformly graded in size from coarse to fine.
3. Hydrated lime—any good brand of prepared hydrated lime or well burned slaked lime putty will be accepted.

PROPORTIONS

FIRST COAT:—1 cement
1/10 lime
2 sand

SECOND COAT:—1 cement
1/10 lime
2½ sand

THIRD COAT:—1 cement
1/10 lime
3 sand

“DON'TS” WHICH MERIT YOUR CONSIDERATION

Don't have your hollow tile dumped from a truck, but have each size of tile stacked by itself. This will save time and money when your masons are ready for tile, besides doing away with breakage.

Don't patch up your job with brick. NATCO XXX Hollow Tile are made in proper shapes and sizes; it is therefore very seldom necessary to use brick.

Don't use too much lime in your mortar. It weakens the mortar and spoils your reputation.

Don't fail to cover up the top course of tile in wall at quitting time. This protects your work and prevents the filling of cells with rain or snow.

Don't leave any holes or crevices on the outside or inside of the wall. Be sure all joints are well sealed. Above all, do not depend upon the stucco to fill up the mortar joints.

Don't allow your mason to break up a lot of tile when they require small pieces, as we ship a percentage of fractional tile in each order.

Don't use the nest of 1 inch slabs as full tile. They should be broken apart and single slab used for bearing under joists, for working up to the story heights, sills, etc.

Don't cut holes into the tile in which to frame your joists, but use the facing tile at ends of beams, and other tile between beams. Remember that the strength of your wall depends upon thorough bearing of webs and shells, and every hole weakens the wall, and is the easiest way for dampness to penetrate.

Don't forget to put proper drips on the underside of the sills. This is very important.

Don't use special arch lintels for spans wider than 5 feet. These should be made of stock tile reinforced or concrete girders faced with tile.

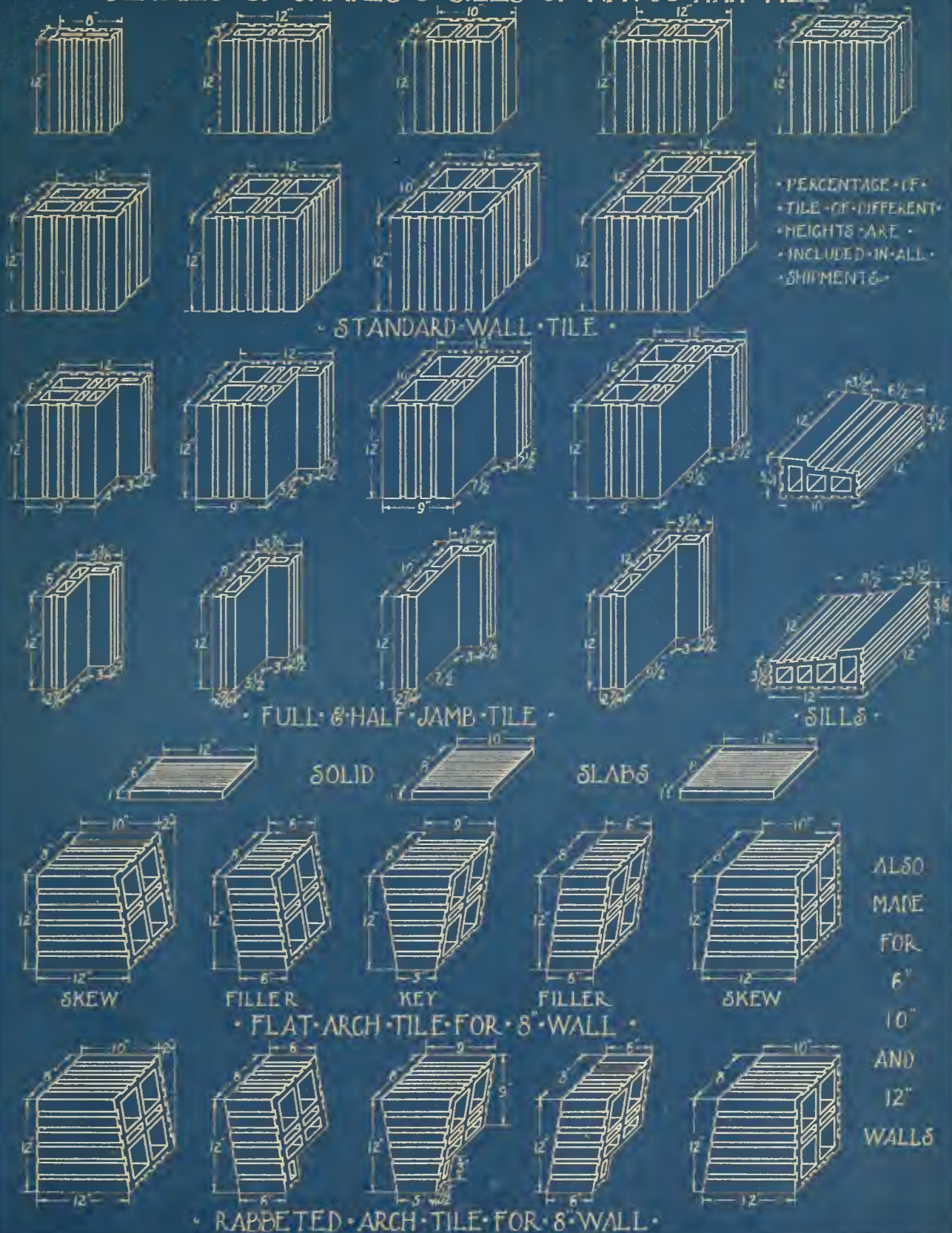
Don't forget that all wooden frame work will shrink; therefore, special care should be taken to thoroughly calk between all wood work and hollow tile.

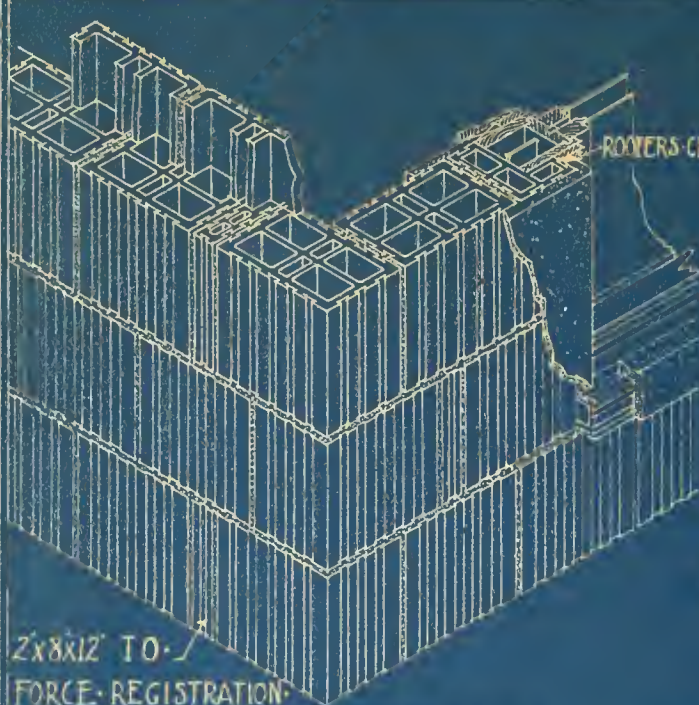
Don't forget to use a good waterproofing compound in the finish coat of your stucco, if the house is situated in a position exposed to driving storms.

Don't try to apply stucco during freezing weather.

Don't guess where we figured the various sizes of tile to be used, as we will gladly make notations of different sizes, etc. on plans, if you will send them to us, or will send our representative to see you. Remember that we are glad to give you any information for we are just as anxious as you are to have the work satisfactory.

• DETAILS OF SHAPES & SIZES OF NATCO XXX-TILE •

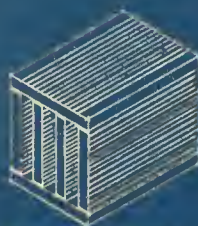




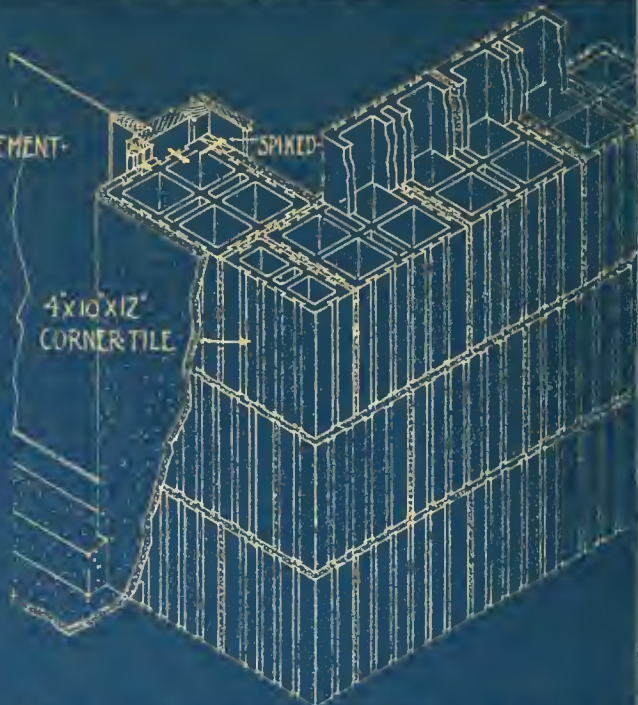
ISOMETRIC VIEW OF 8 INCH TILE WALL



ISOMETRIC VIEW OF NEST AS
MANUFACTURED

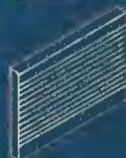


NEST OF 1 INCH SLABS



ISOMETRIC VIEW OF 10" TILE WALL

TAP-ON CORNERS TO
SEPARATE SLABS



ISOMETRIC VIEW OF SINGLE
1" SLAB

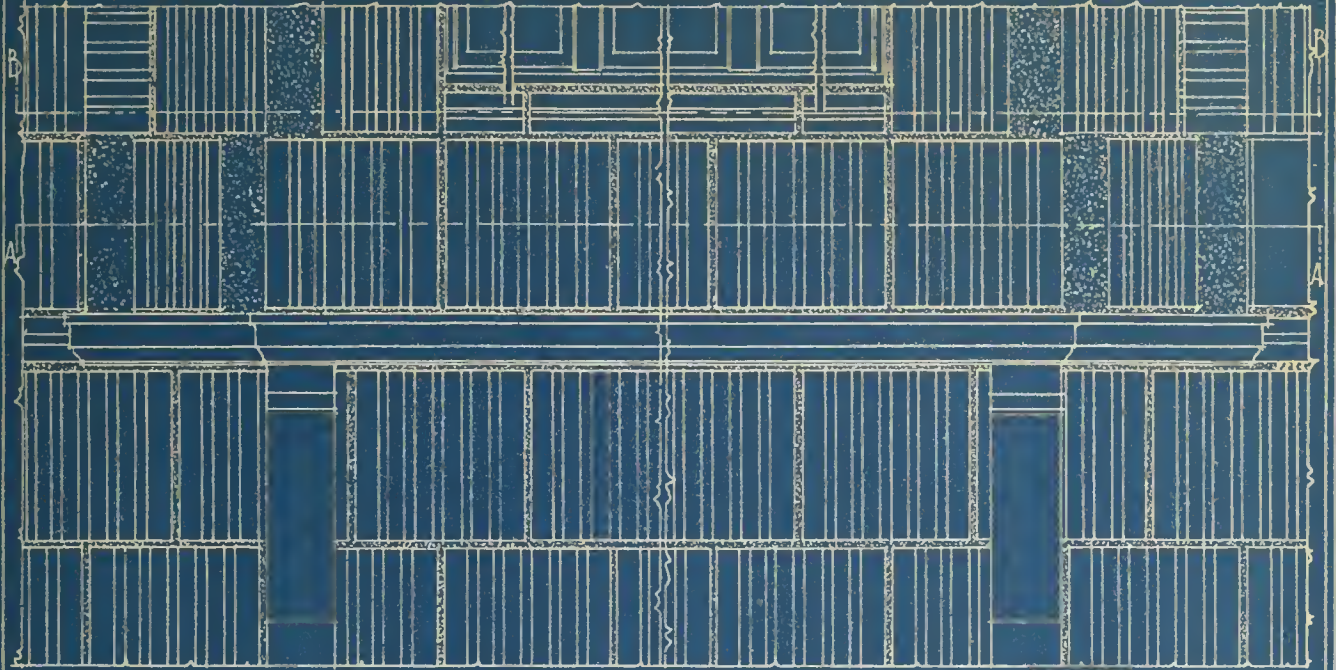


ISOMETRIC VIEW OF 12" TILE WALL

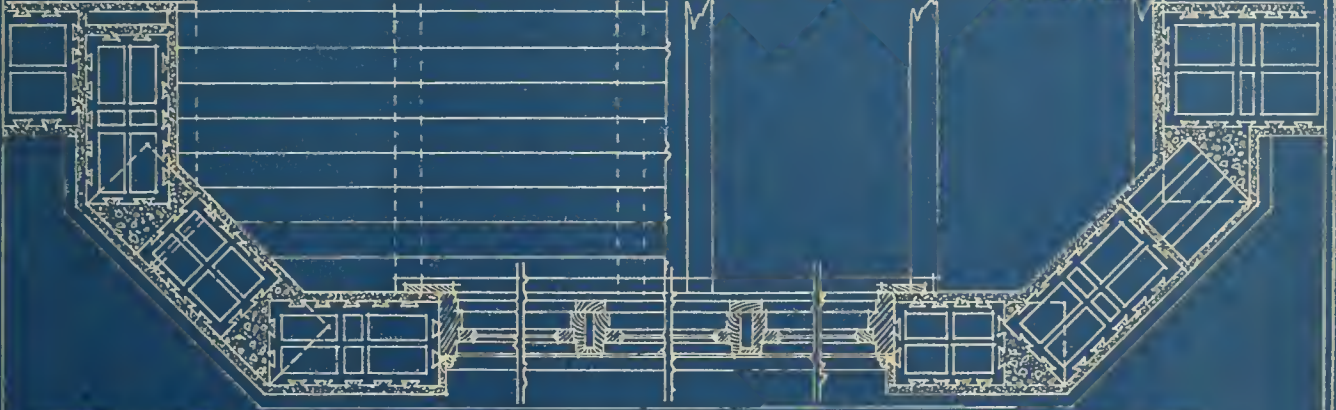


ISOMETRIC VIEW OF 14" TILE WALL

· DETAILS · OF · NATCO · HOLLOW · TILE · BAY · WINDOW ·



· ELEVATION · OF · BAY · SHOWING · METHOD · OF · LAYING · CORNER · TILTS ·



· PLAN · THRU ·
· LINE · A · A ·

· PLAN · THRU ·
· LINE · B · B ·

· FLOOR · LINE ·

· REINFORCED · CONCRETE · SLAB ·
· ORNAMENTAL · MOULD · RUN · ON · FACE ·

· REINFORCED · CONCRETE · BRACKETS · CAST · IN · PLACE ·
· ORNAMENTAL · FACES · FORMED · IN · CASTING ·

· SIDE · ELEVATION · OF · BAY ·

· SECTION · OF · BAY ·

DETAIL OF TYPICAL DOUBLE HUNG WINDOW CONSTRUCTION

SCALE

16 INCHES

NOTE: ARCH LINTEL WITH SKEW BACK & NECESSARY FILLERS & KEY ADAPTED TO OPENINGS NOT EXCEEDING 5' IN CLEAR SPAN. KEY FILLER SKEW BACK

STUCCO COVERING

ELEVATION

CAULK WITH ROOFERS CEMENT

PLAN SHOWING SPECIAL JAMB TILE

CONCRETE FILL

PLASTER

STUCCO

ROOFERS CEMENT

STONE

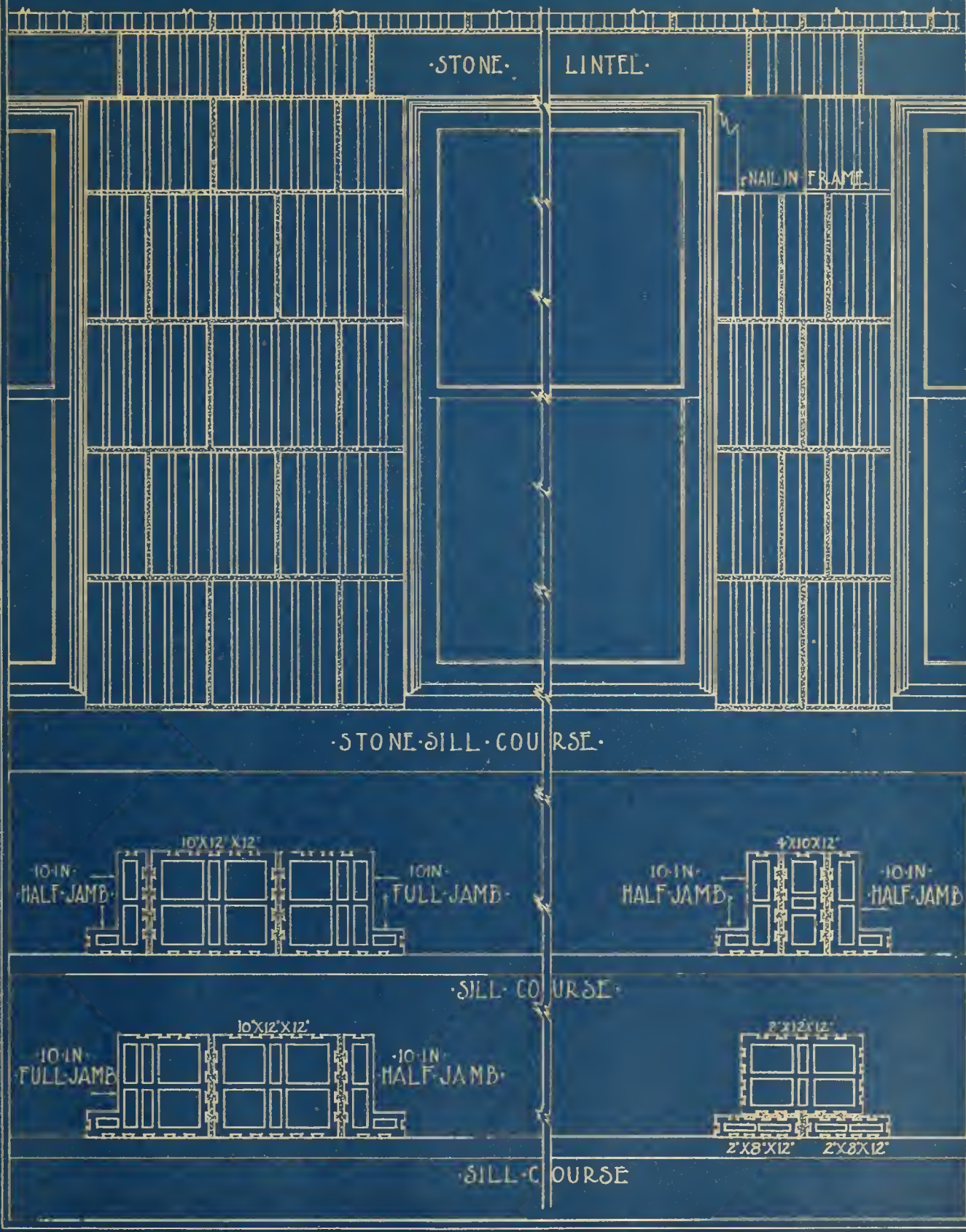
SECTION OF HEAD OF REGULAR TILE

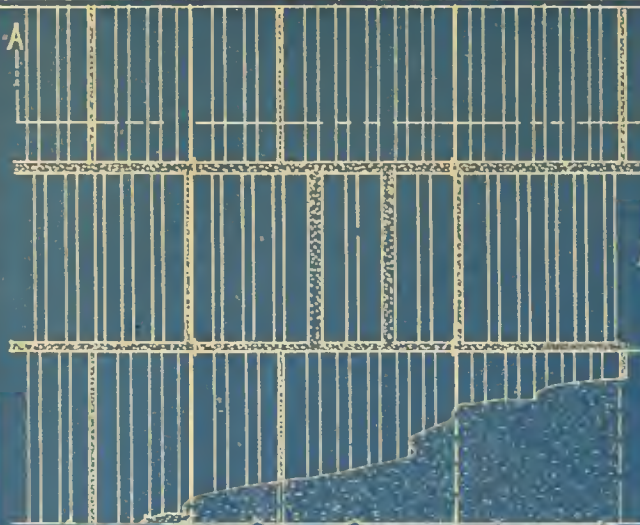
SECTION OF HEAD OF SPECIAL TILE

SECTION OF PATENTED TILE SILL

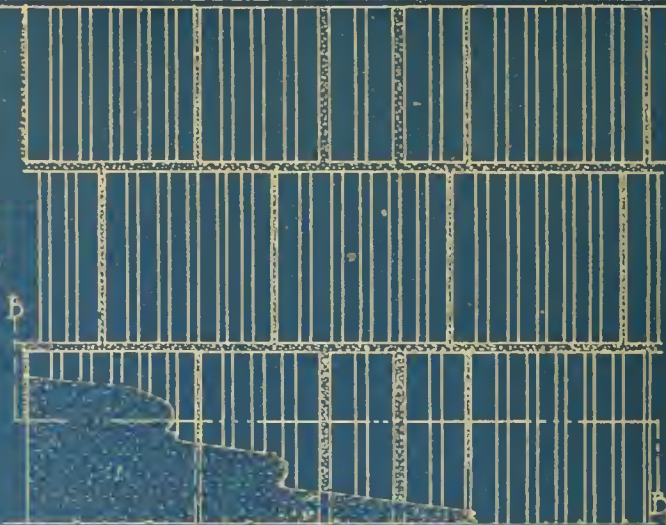
SECTION OF STONE SILL

METHOD OF FORMING PIERS BETWEEN DOUBLE HUNG WINDOWS.

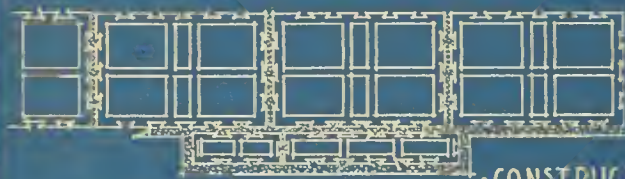




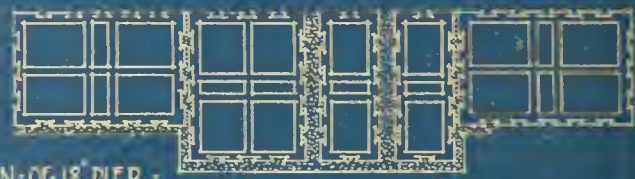
ELEVATION OF PIER SIDE



ELEVATION OF WALL SIDE



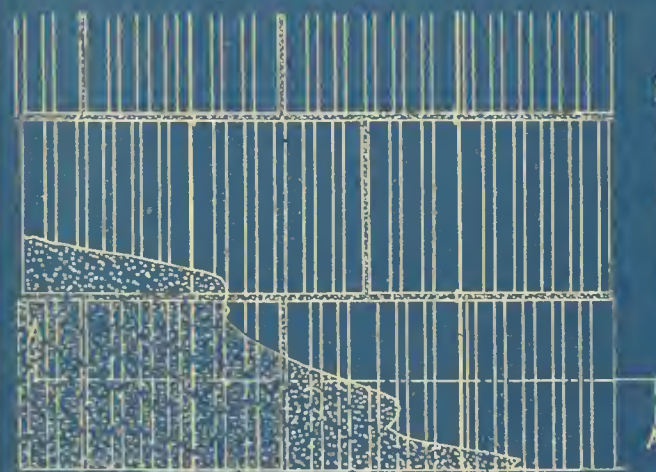
PLAN AT COURSE A-A



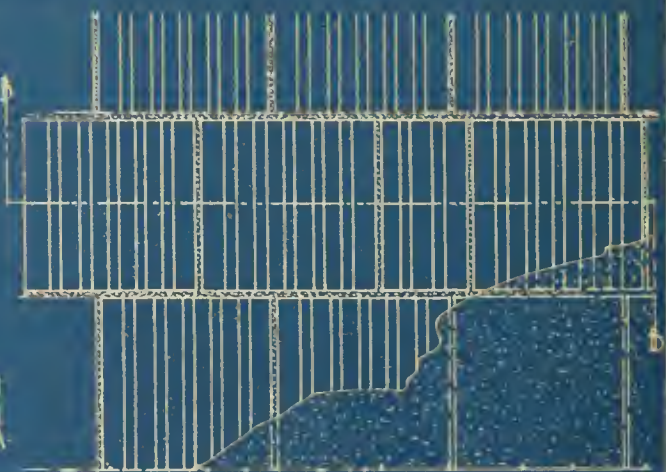
PLAN AT COURSE B-B

CONSTRUCTION OF 18" PIER

IN AN 8" HOLLOW TILE WALL



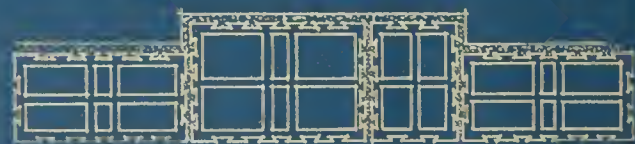
ELEVATION OF PIER SIDE



ELEVATION OF WALL SIDE



PLAN AT COURSE A-A

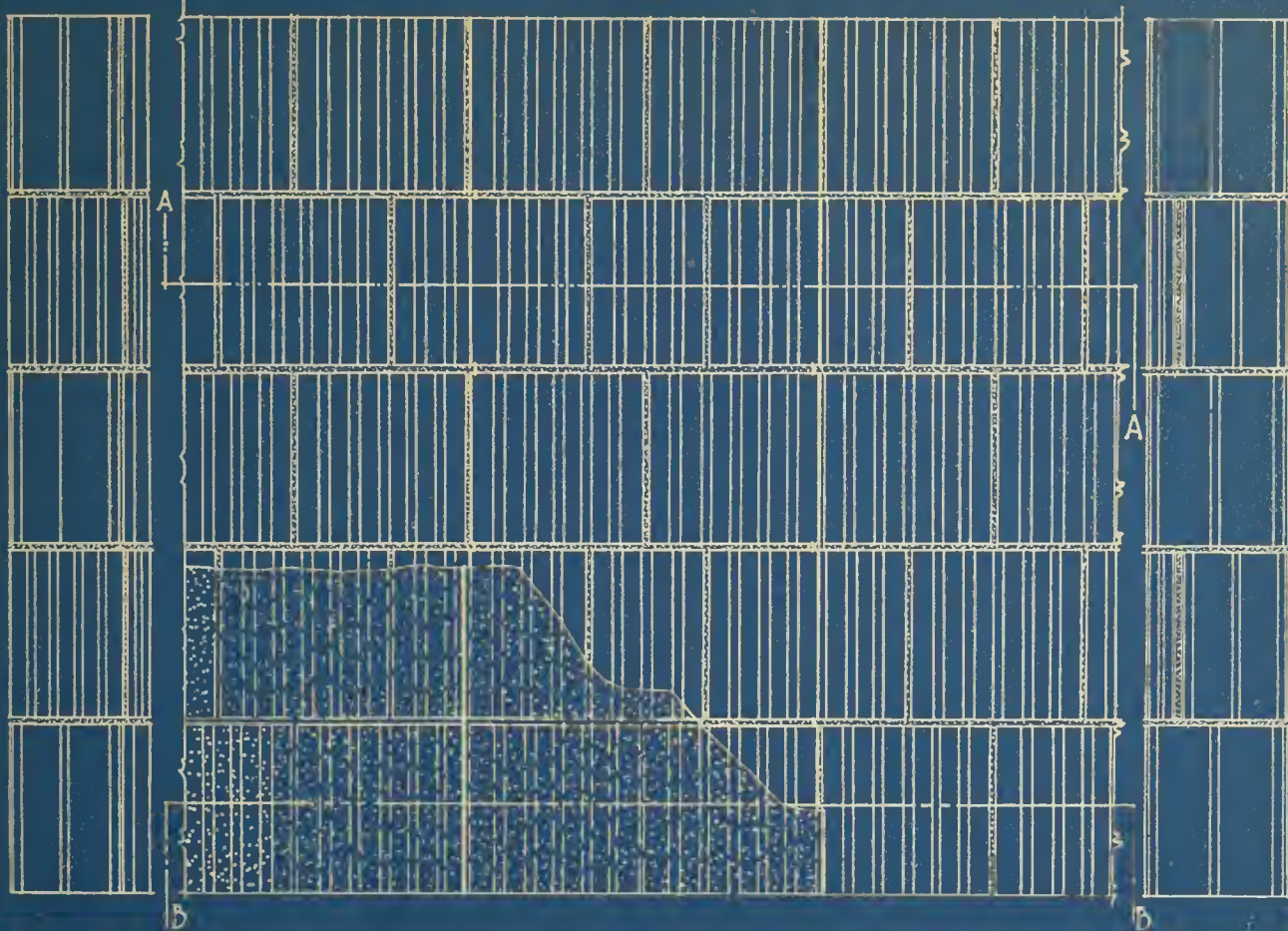


PLAN AT COURSE B-B

CONSTRUCTION OF 18" PIER

IN A 6" HOLLOW TILE WALL

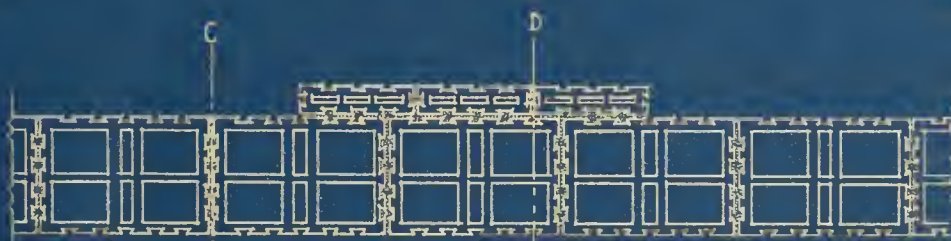
• 24-INCH • PIER • OR • PILASTER • IN • AN • 8" NATCO • WALL •



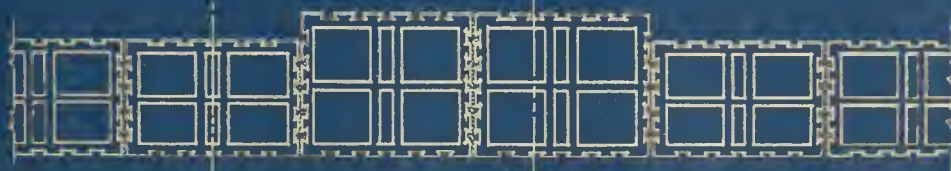
SECTION THRU WALL
• AT • C • C •

• ELEVATION • OF • PILASTER •

SECTION THRU PILASTER
• AT • D • D •



• PLAN • AT • COURSE • A • A •

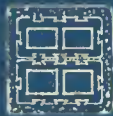


• PLAN • AT • COURSE • B • B •

DETAIL OF HOLLOW TILE PIERS WITH STUCCO COVERING



ELEVATION



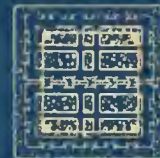
PLANS OF 10" TILE PIER - 4x8" TILE



ELEVATION



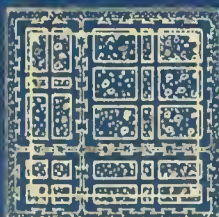
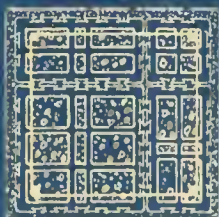
ELEVATION



14" TILE PIER FILLED WITH CONCRETE AND REINFORCING RODS AT CORNERS TIED WITH $\frac{1}{4}$ " BANDS

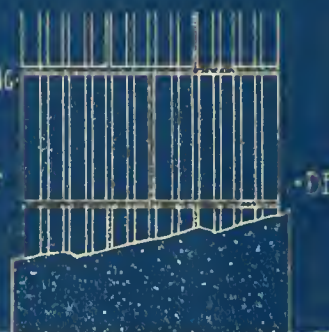


ELEVATION



PLANS OF 20" PIER REINFORCING AT CORNERS TIED WITH $\frac{1}{4}$ " BANDS

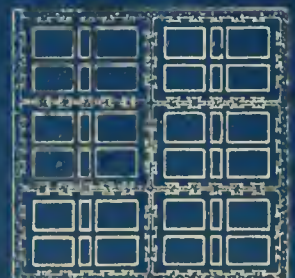
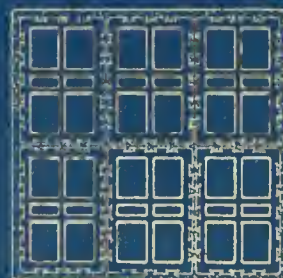
26" ROUND COLUMN WITH OR WITHOUT REINFORCING ACCORDING TO LOAD RODS WRAPPED WITH WIRE



ELEVATION



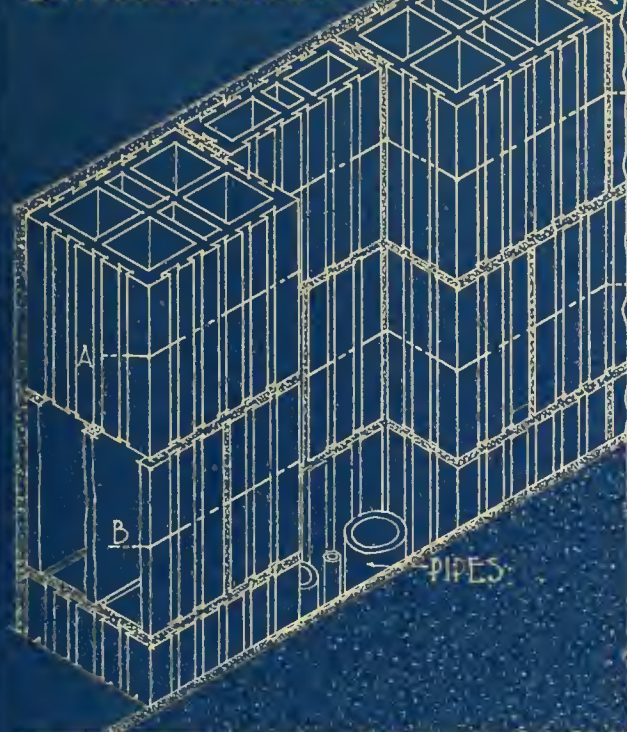
DETAIL OF BAND



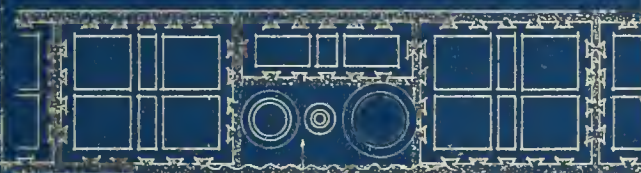
PLANS OF 26" PIERS

METHOD OF CHASING IN NATCO

EXTERIOR STUCCO



ISOMETRIC VIEW SHOWING 6"x12" CHASE FOR PIPES IN 10" NATCO TILE WALL



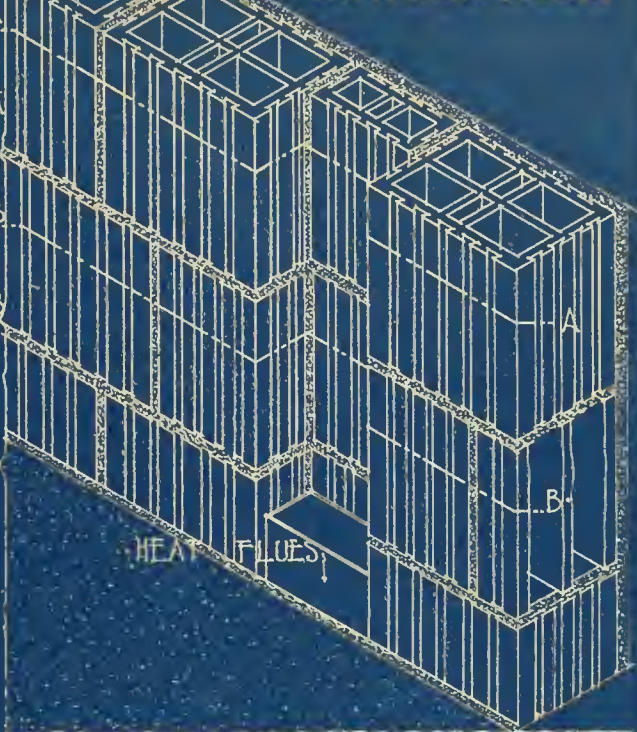
PIPE CHASE
PLAN THRU LINE A-A



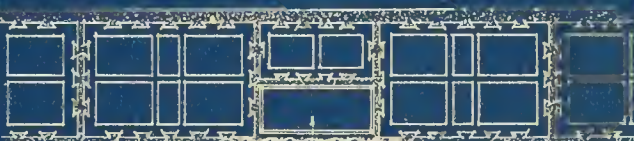
PLAN THRU LINE B-B

WALLS FOR HEAT PIPES ETC

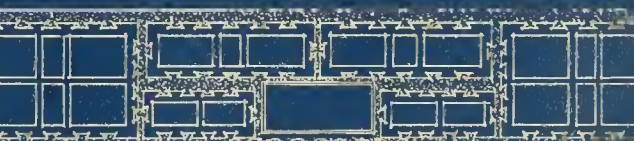
EXTERIOR STUCCO



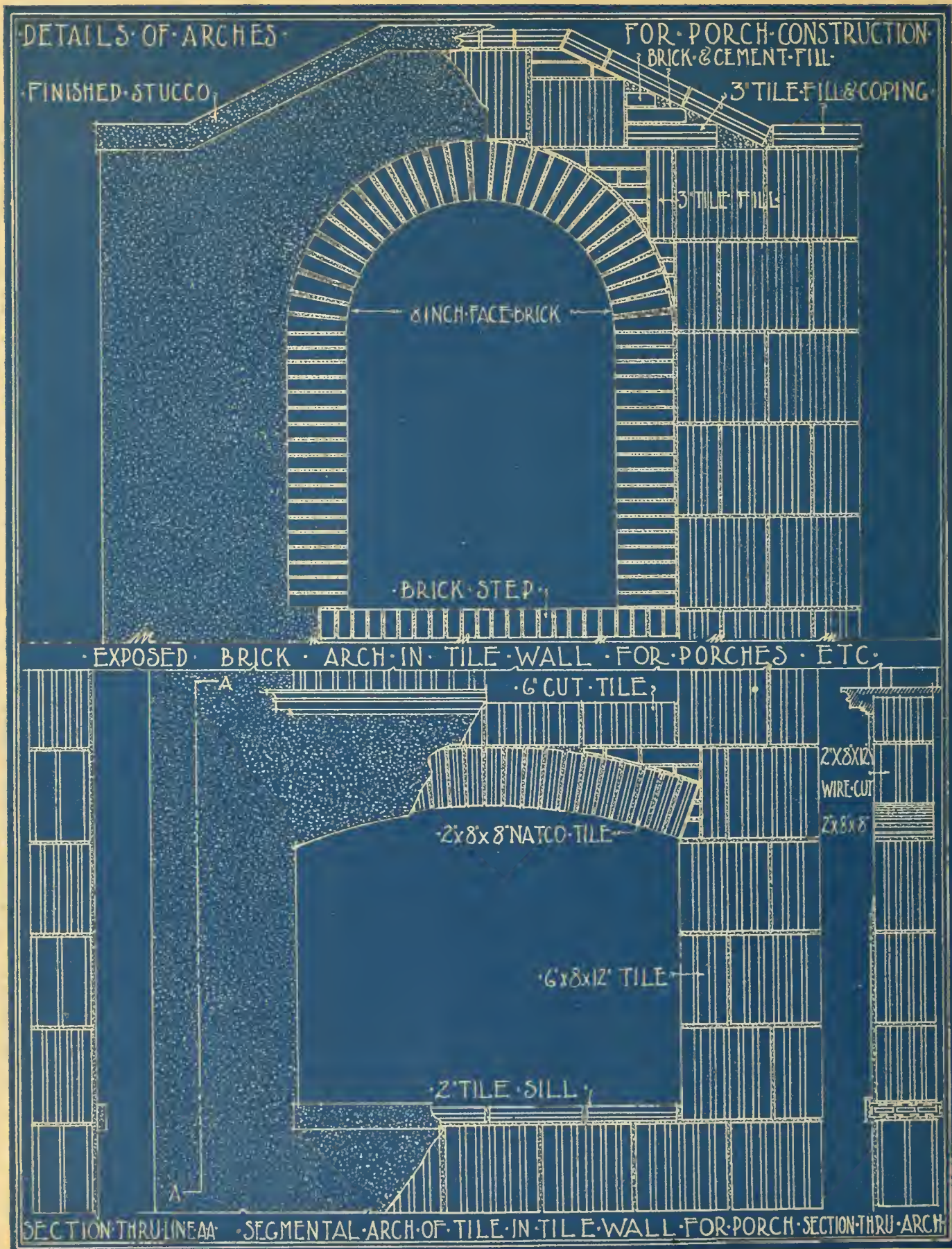
ISOMETRIC VIEW SHOWING 4"x9" CHASE FOR PIPES IN 8" NATCO TILE WALL



HEAT FLUE
PLAN THRU LINE A-A



PLAN THRU LINE B-B



DETAILS OF GABLES AND BUTTRESSES

SECTION SHOWING
RAFTER ON TOP OF
WALL AND VERGE
BOARD OUTSIDE

SECTION SHOWING
RAFTER INSIDE OF
WALL STUCCO
OUTSIDE

METHOD OF BUILDING GABLE USING
FULL STOCK TILE & BRICK FILL

METHOD OF BUILDING GABLE USING
HALF STOCK TILE & BRICK FILL

ELEVATION
OF TILE BUT-
TRESS WITH
CONCRETE CAPS

SECTION
SHOWING
THE BUT-
TRESS
WITH
CONCRETE
CAPS & FILL

ELEVATION
OF THE BUT-
TRESS WITH
TILE CAP

STUCCO

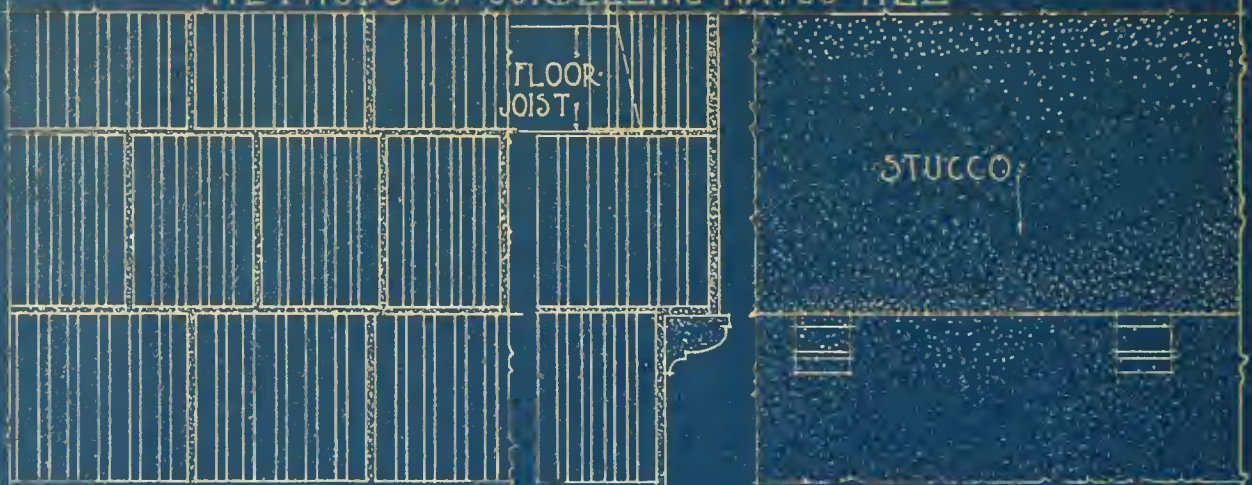
STUCCO

STUCCO

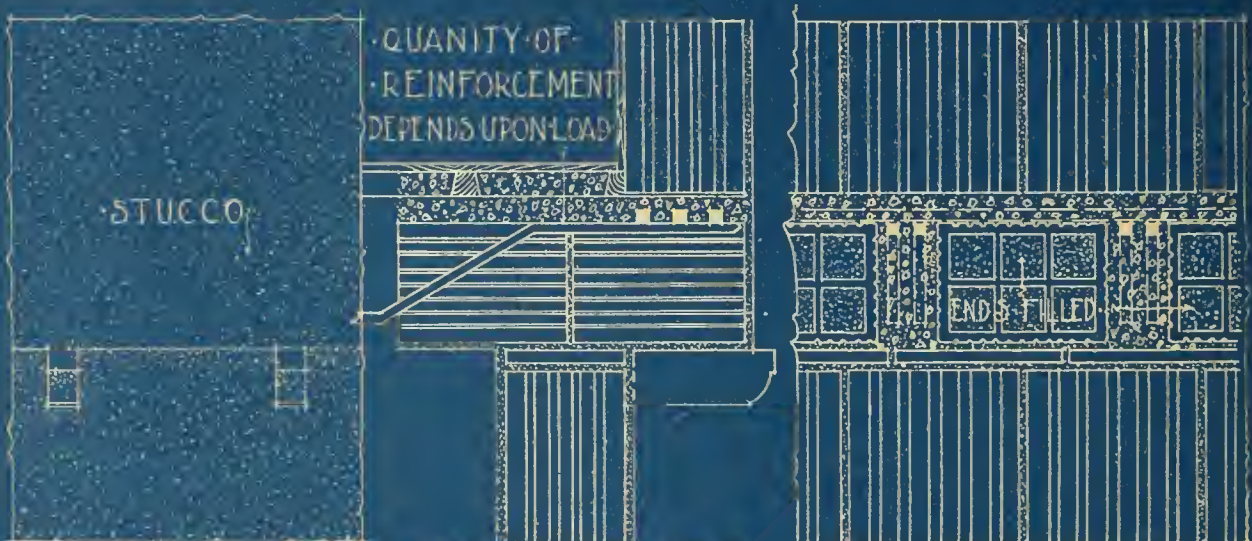
STUCCO

SECTION
SHOWING
TILE BUT-
TRESS
WITH TILE
CAP &
CONCRETE
FILL

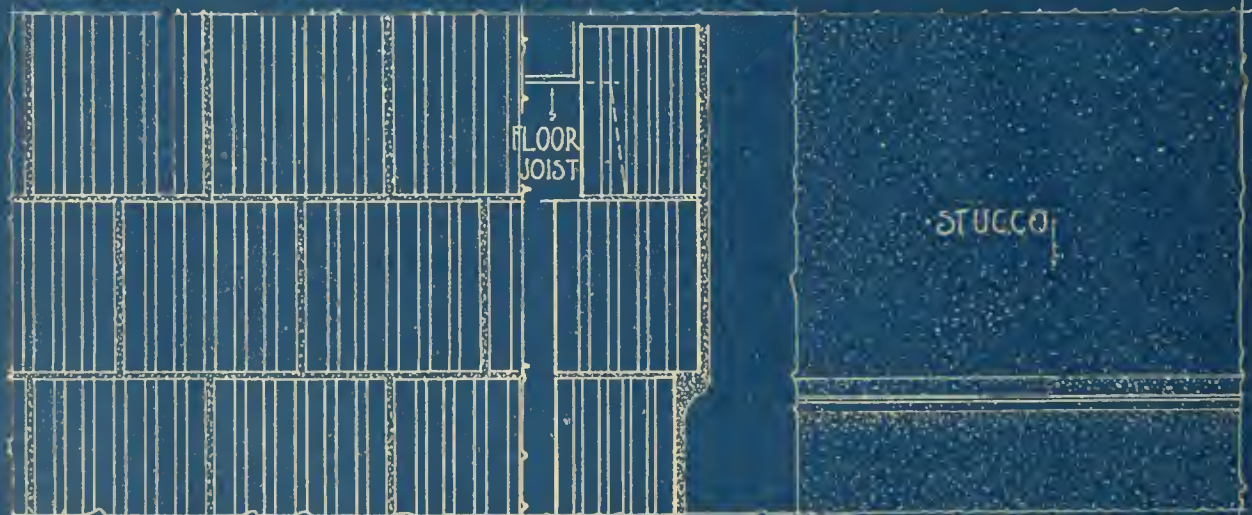
METHODS OF CORBELLING NATCO TILE



4" CORBEL IN AN 8" NATCO TILE WALL WITH WOOD FLOOR & LIGHT LOAD



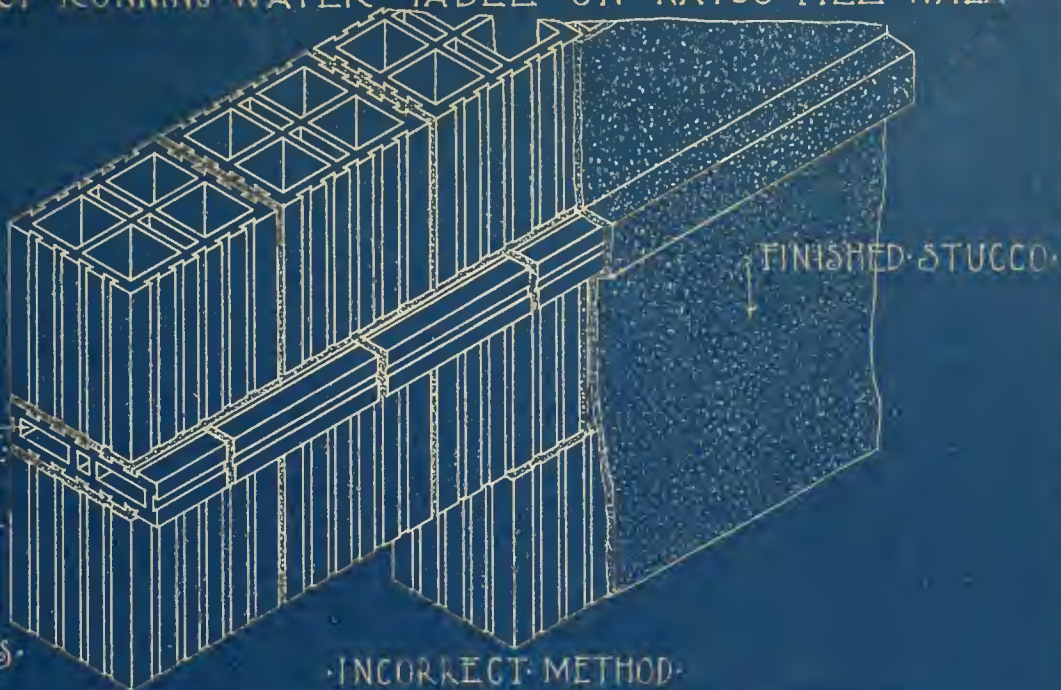
8" CORBEL IN AN 8" NATCO WALL WHERE FIRE-PROOF FLOORS ARE USED



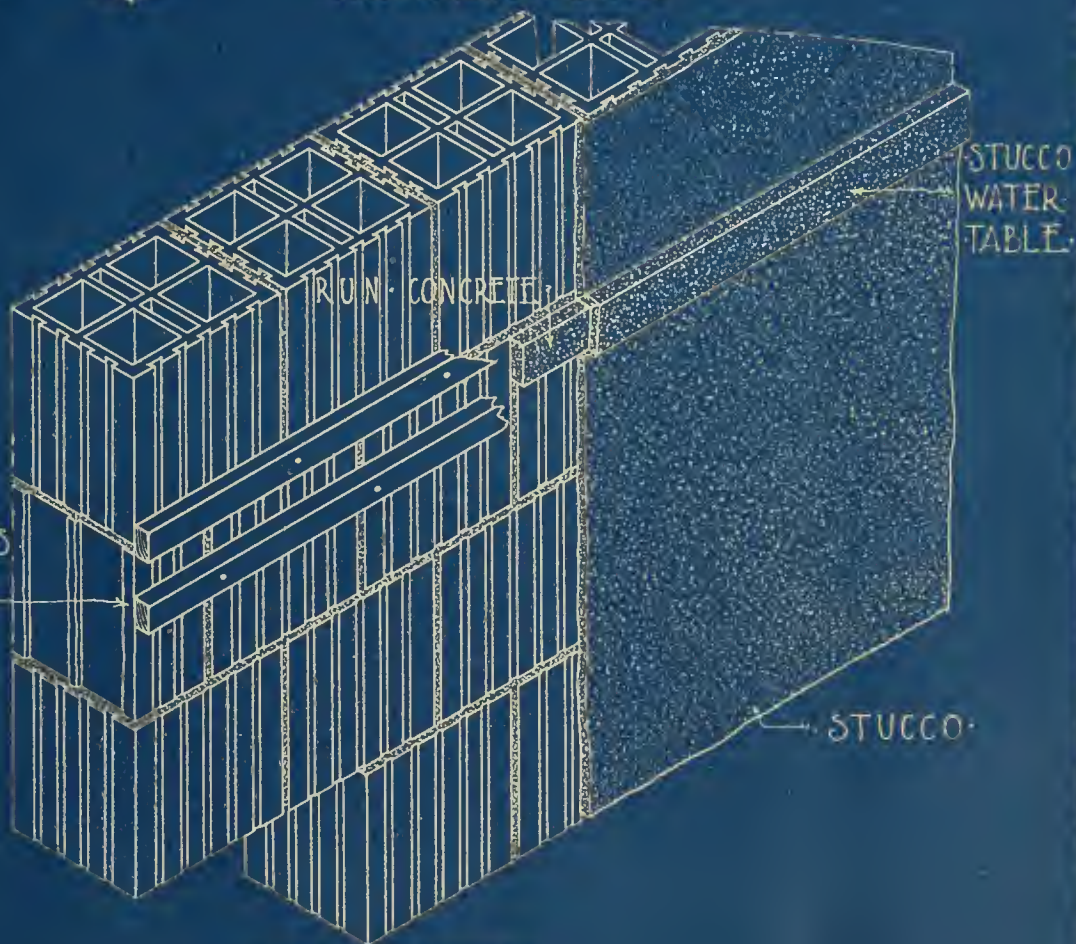
2" CORBEL IN AN 8" NATCO TILE WALL USING 10X12X12 TILE

METHOD OF RUNNING WATER TABLE ON NATCO TILE WALL

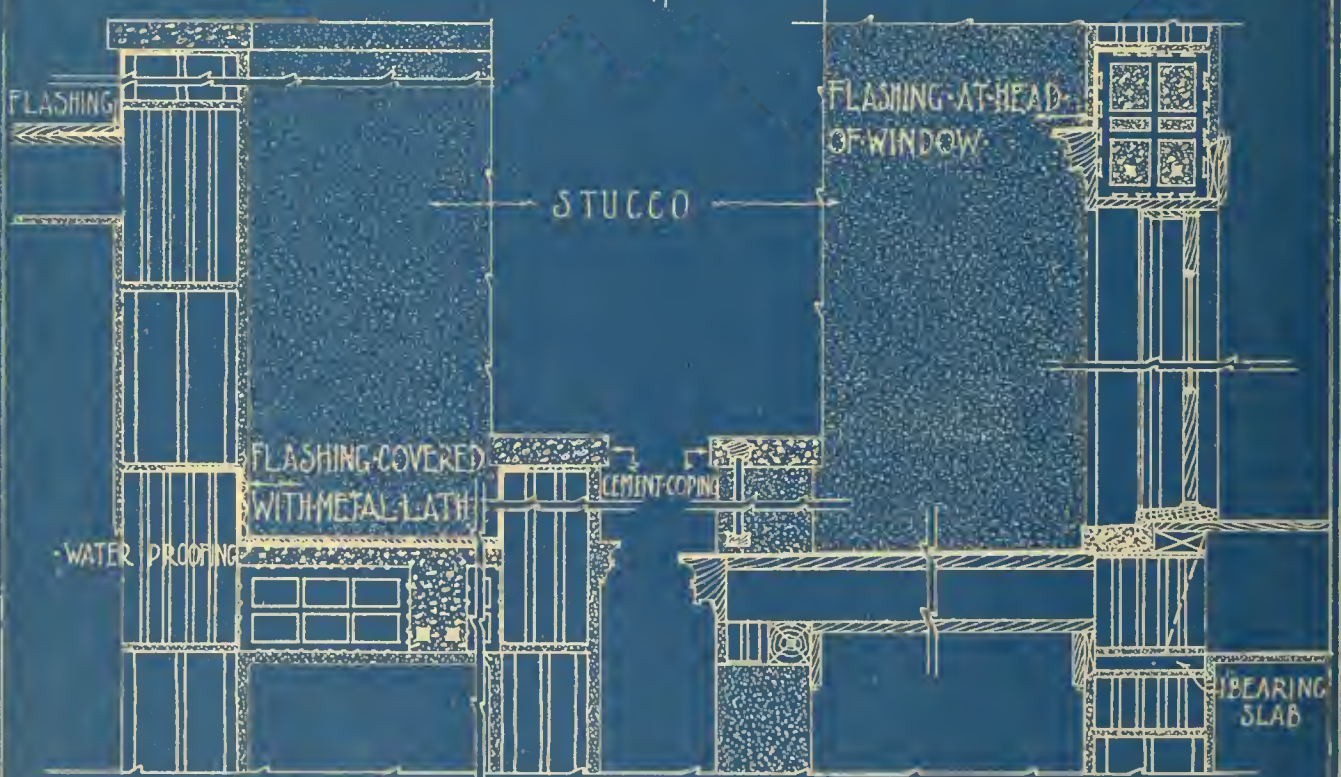
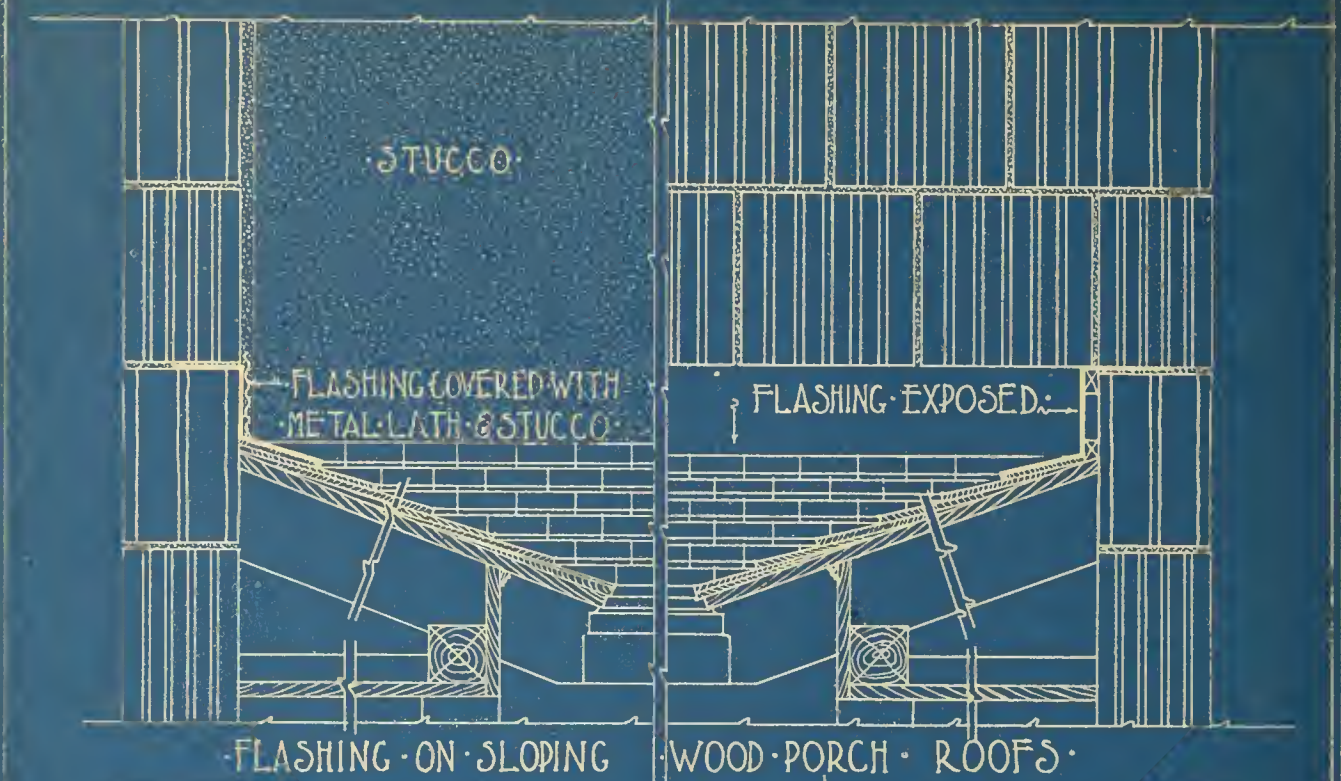
WEAK POINT IN
WALL DUE TO TILE
LAID FLAT:
FLAT BED CAUS-
ING DAMPNES-
AND DOES NOT
ADMIT OF WEBS
REGISTERING



FURRING STRIPS
FOR FORM

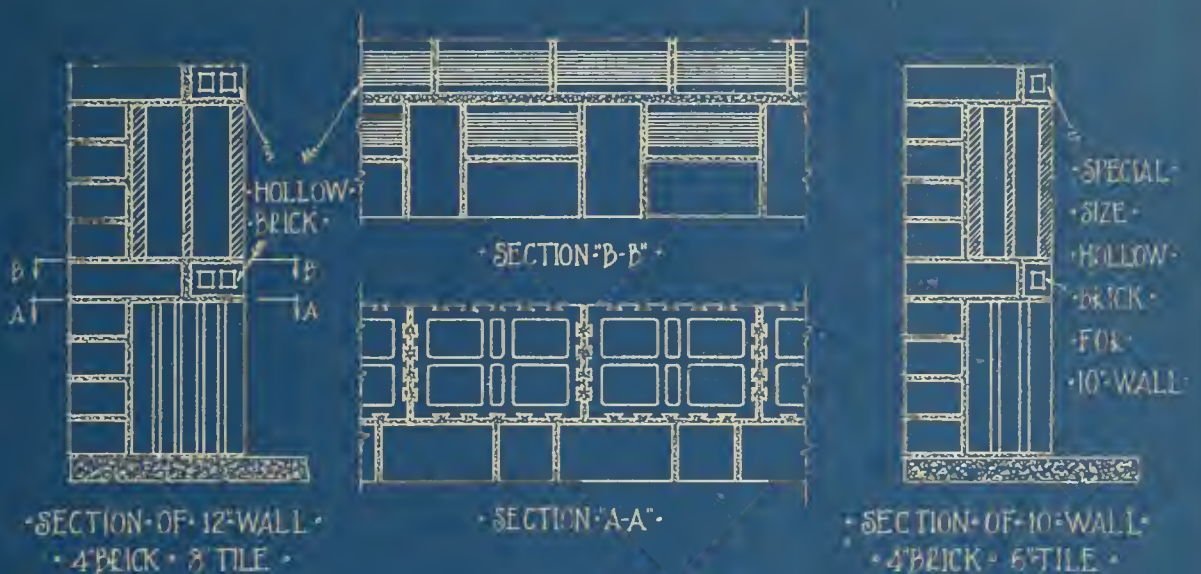


· DETAILS · SHOWING · METHODS · OF · FLASHING · NATCO · TILE · WALLS ·



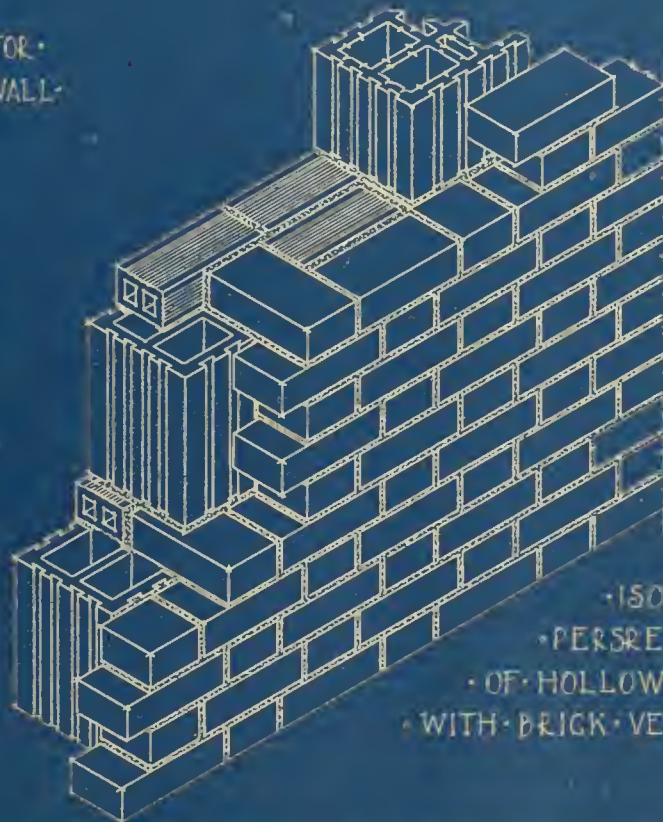
· METHOD · OF · FLASHING · FIREPROOF · PORCH · ROOF · · TIN · DECK · ON · FLAT · WOOD · ROOF ·

BRICK VENEER BONDED INTO HOLLOW TILE



FULL BEARING VALUE FOR
TOTAL THICKNESS OF WALL
IS ALLOWED WHERE
BRICK VENEER IS
BONDED AS SHOWN

WHEN BRICK ARE NOT
BONDED INTO WALL
BUT ARE SECURED
WITH METAL TIES
ONLY THE HOLLOW
TILE BACKING
IS CONSIDERED
AS BEARING WALL

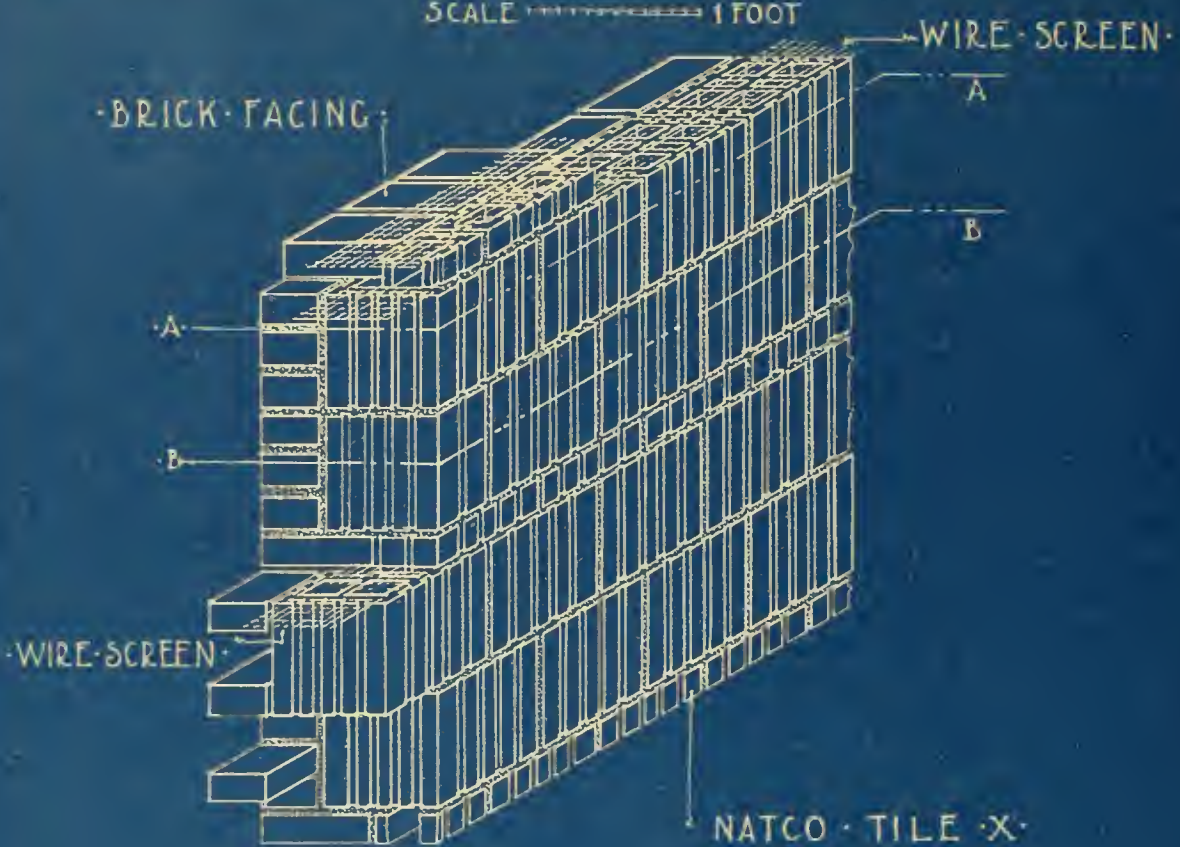


ISOMETRIC
PERSPECTIVE
OF HOLLOW TILE WALL
WITH BRICK VENEER

WHEN NECESSARY HOLLOW TILE WILL BE MANUFACTURED LESS THAN 12" HIGH TO AFFORD PROPER BONDING

SECTION OF EXTERIOR WALL SHOWING NATCO X WITH
BRICK FACING BONDED WITH HEADERS EVERY SEVENTH COURSE

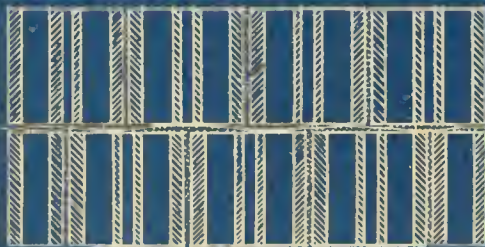
SCALE 1" = 1 FOOT



WIRE SCREEN



PLAN AT A-A



WIRE SCREEN



PLAN AT B-B

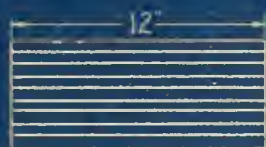
• DETAIL OF NATCO BAKUP TILE WITH BRICK VENEER •

• NATCO BAKUP TILE ARE MADE •
 • IN TWO SIZES 5X8X12 AND 5X4X12 •
 • CORNER TILE FURNISHED FOR •
 • BOTH SIZES •

METAL-TIE

METAL-TIE

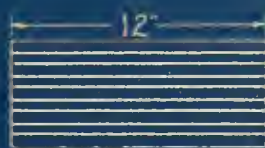
METAL-TIE



• SIDE VIEW •



• END VIEW •



• SIDE VIEW •



• END VIEW •

• ALL NATCO BAKUP TILE ARE SCORED •
 • 3 SIDES AND SMOOTH ON ONE 5'X12' •
 • FACE SO THAT A SMOOTH WALL •
 • INSIDE OR OUT MAY BE HAD IF DESIRED •

• SCORED SIDE •
 • FOR PLASTER •

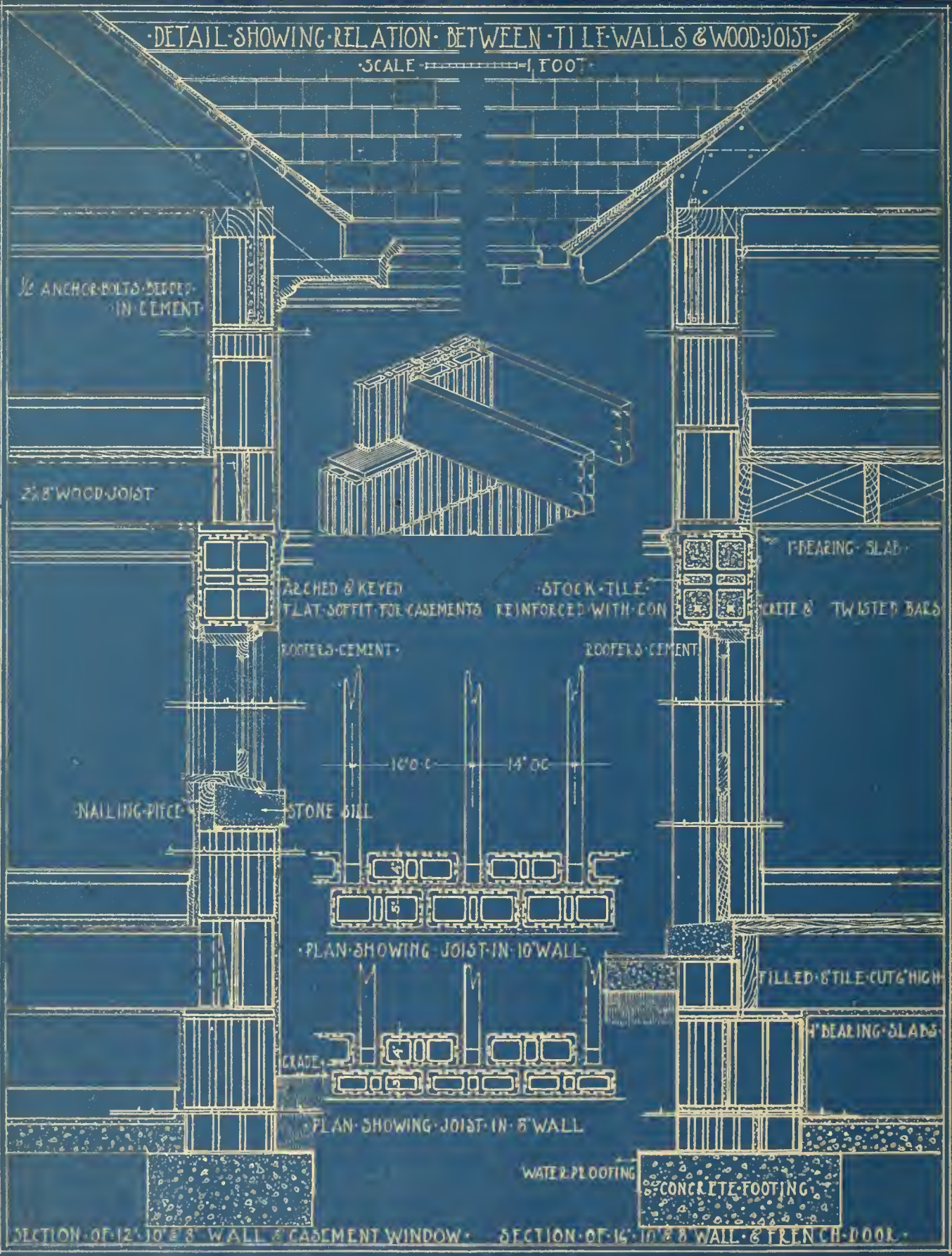
• SMOOTH SIDE •
 • EXPOSED •
 • PRESENTS •
 • FINISHED •
 • WALL •

• SECTION OF WALL SHOWING BRICK VENEER •
 • SECURED WITH METAL TIES •

• SECTION OF WALL SHOWING BRICK VENEER •
 • BONDED WITH BRICK HEADERS •

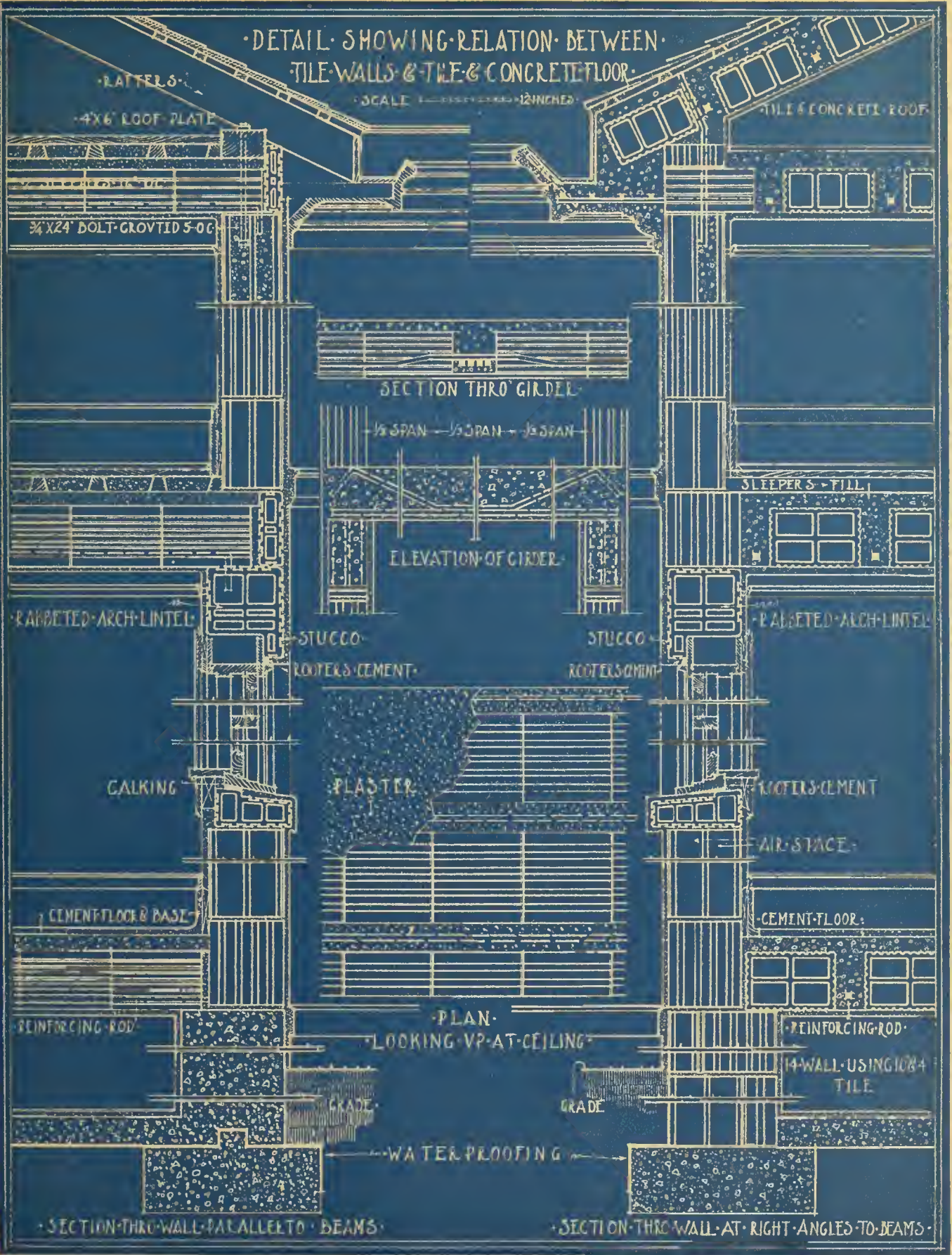
DETAIL SHOWING RELATION BETWEEN TILE WALLS & WOOD JOIST

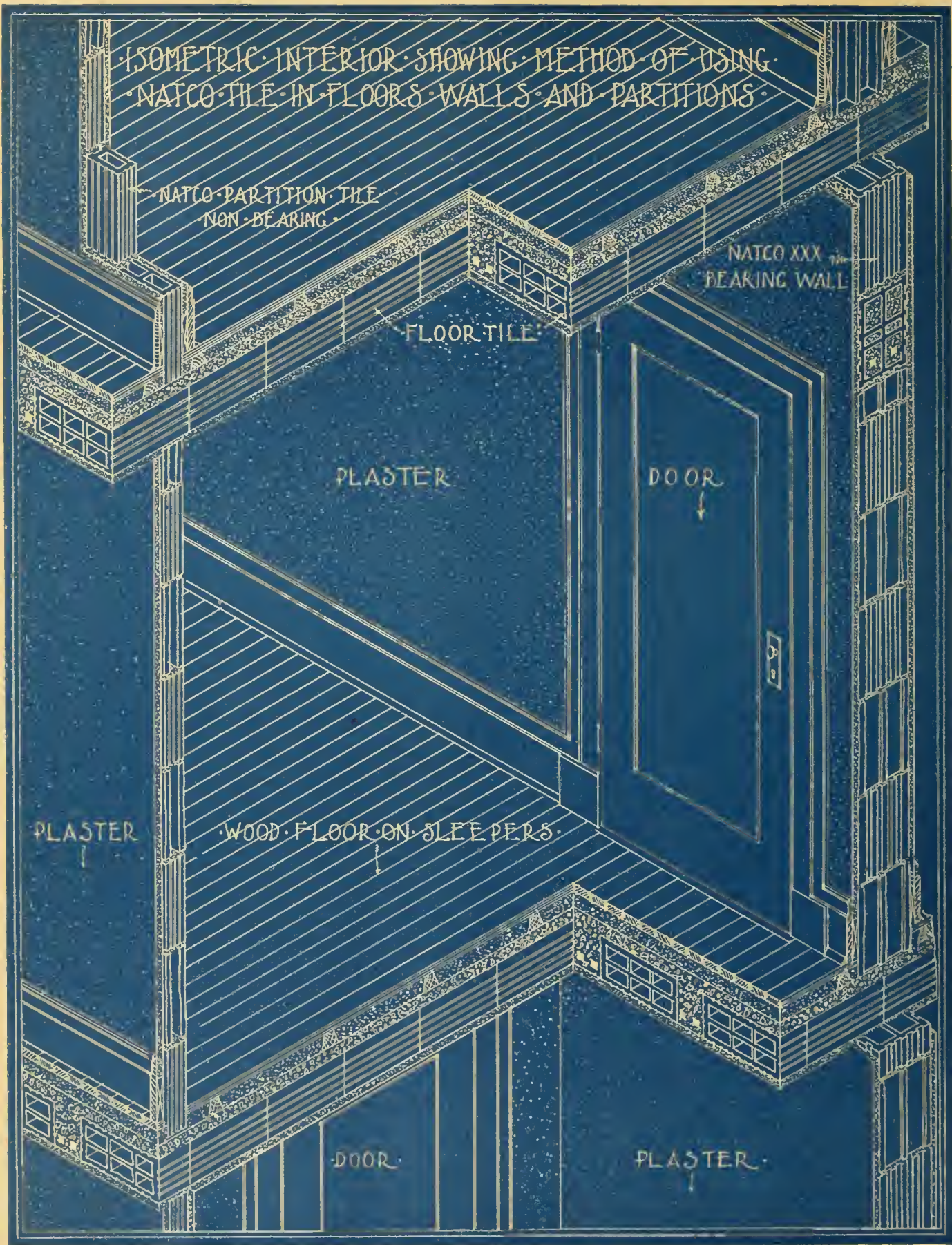
SCALE 1" = 1' 0"



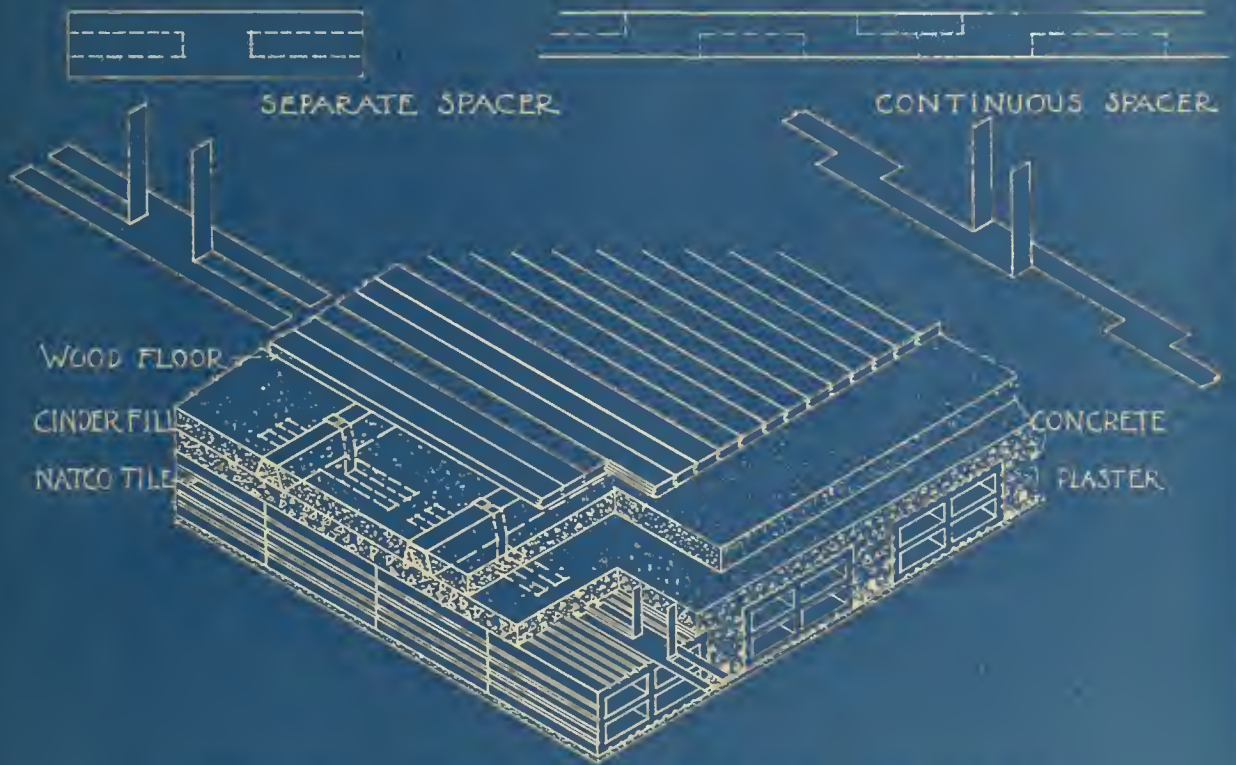
·DETAIL·SHOWING·RELATION·BETWEEN·
·TILE·WALLS·&·TILE·&·CONCRETE·FLOOR·

·SCALE·—————12·INCHES·

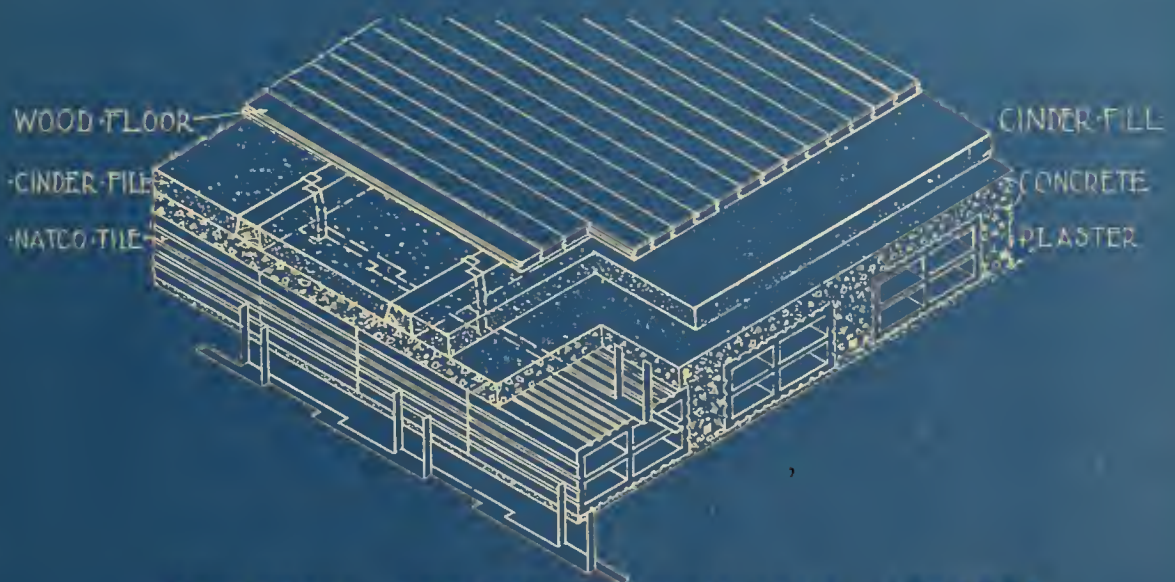




METHODS OF SECURING WOOD SLEEPERS TO NATCO FIREPROOF FLOORS

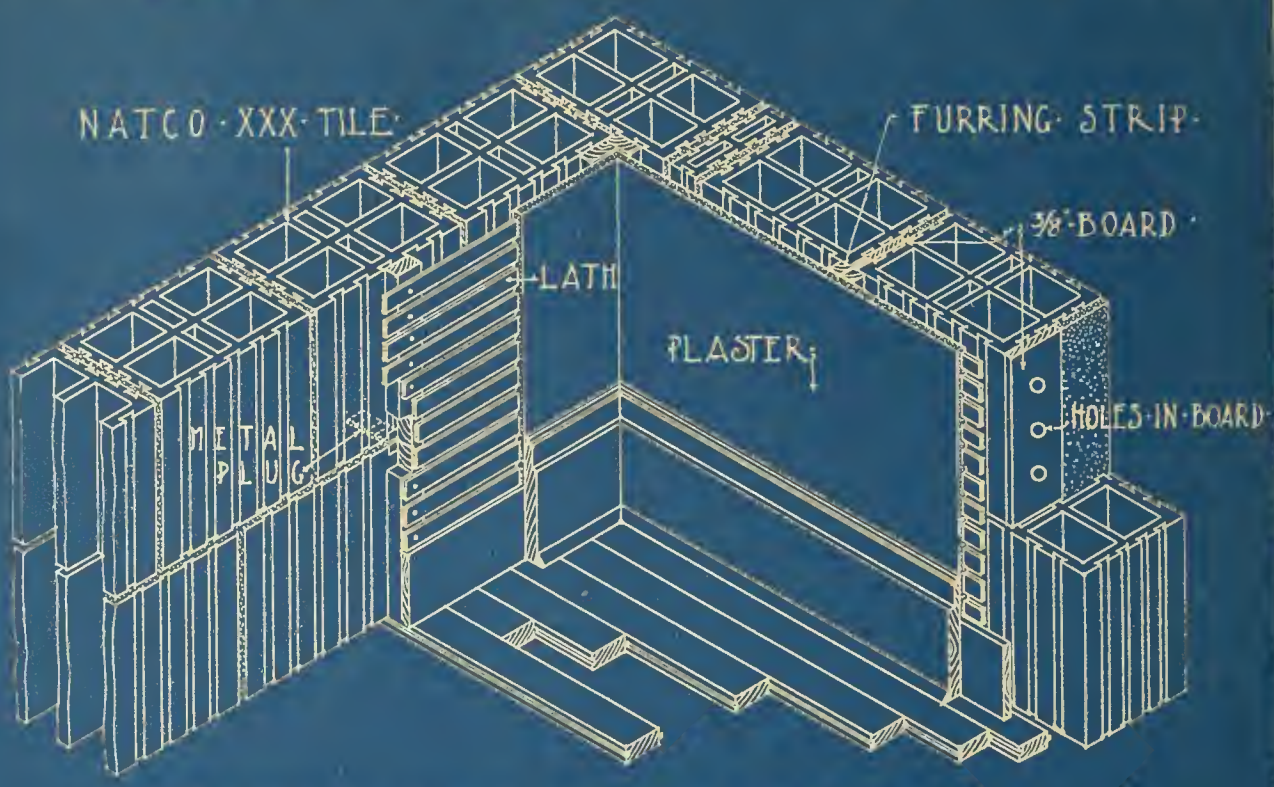


ISOMETRIC SHOWING SEPARATE SPACERS

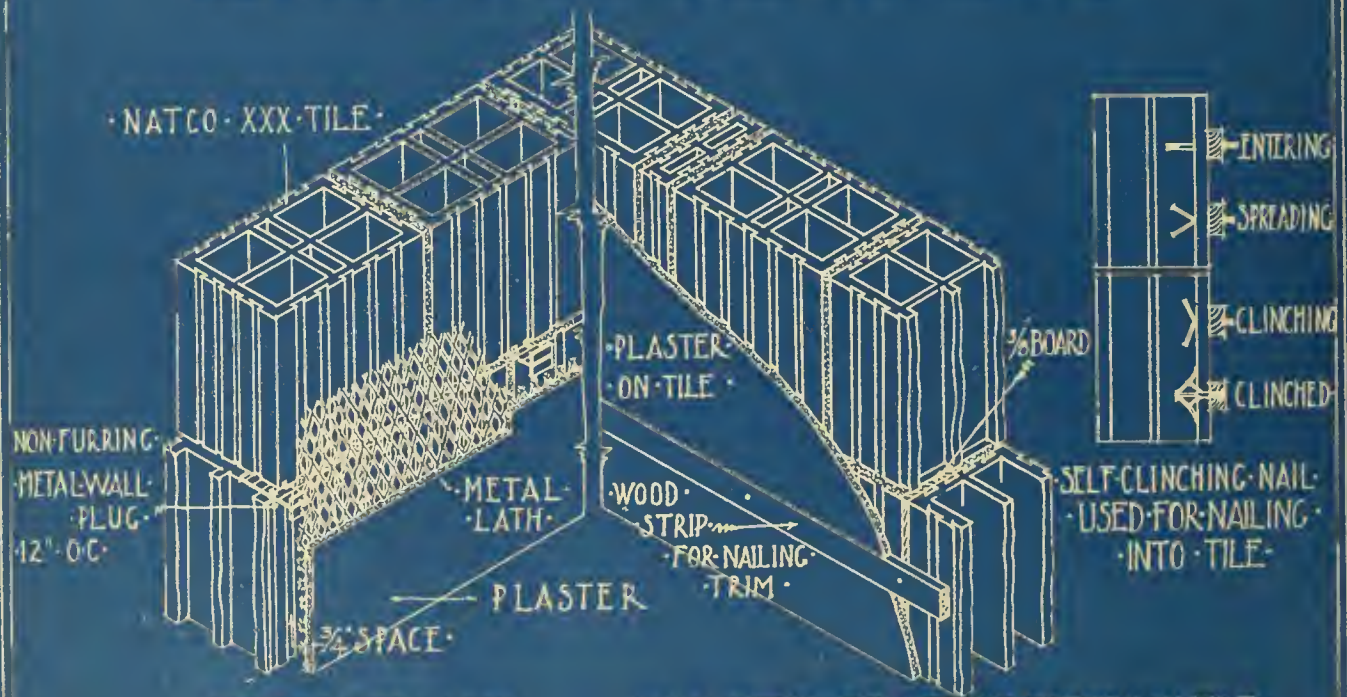


ISOMETRIC SHOWING CONTINUOUS SPACERS

METHOD OF FASTENING TRIM AND FURRING TO NATCO WALLS



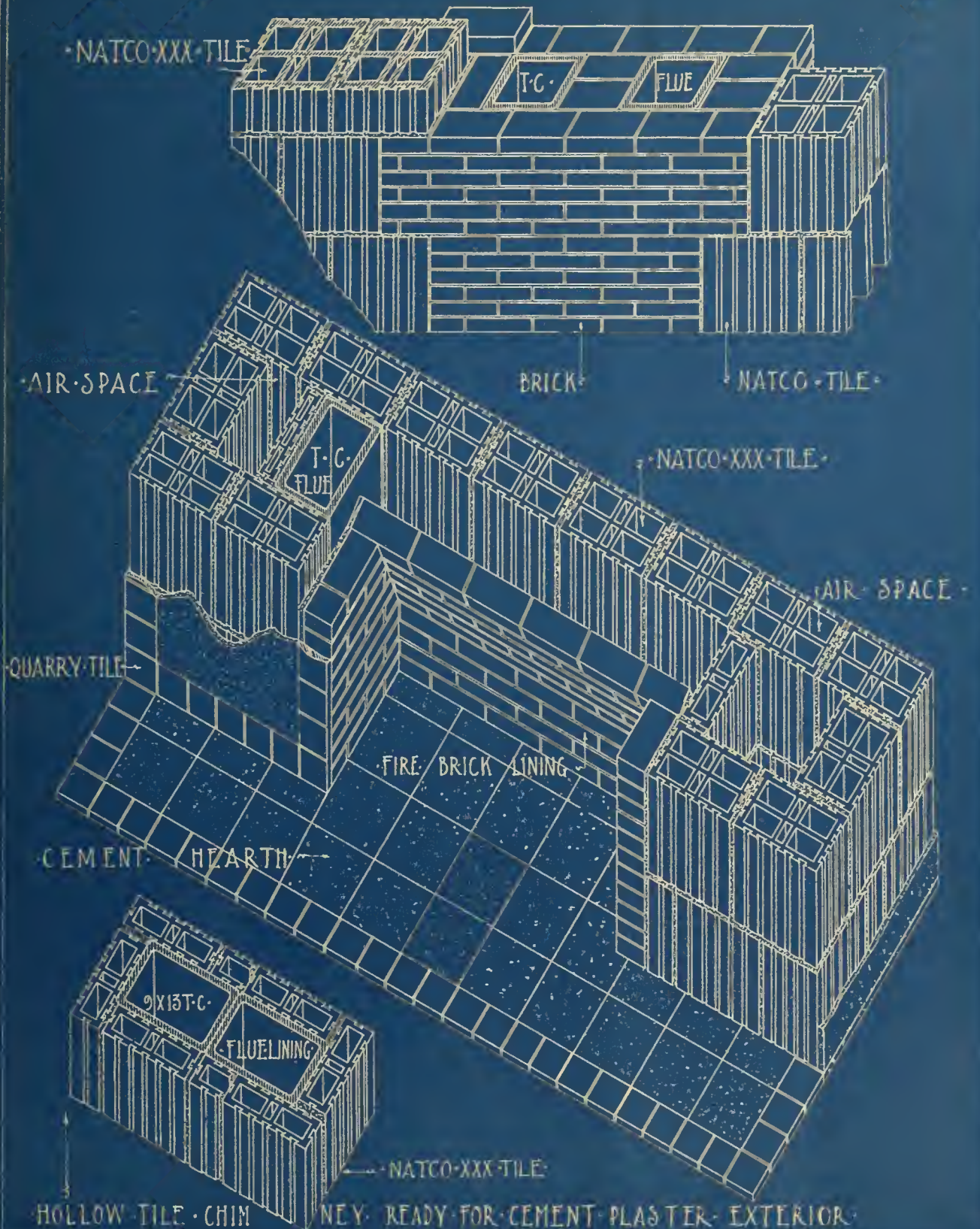
WOOD & METAL PLUGS IN NATCO TILE CONSTRUCTION



SECURING METAL LATH

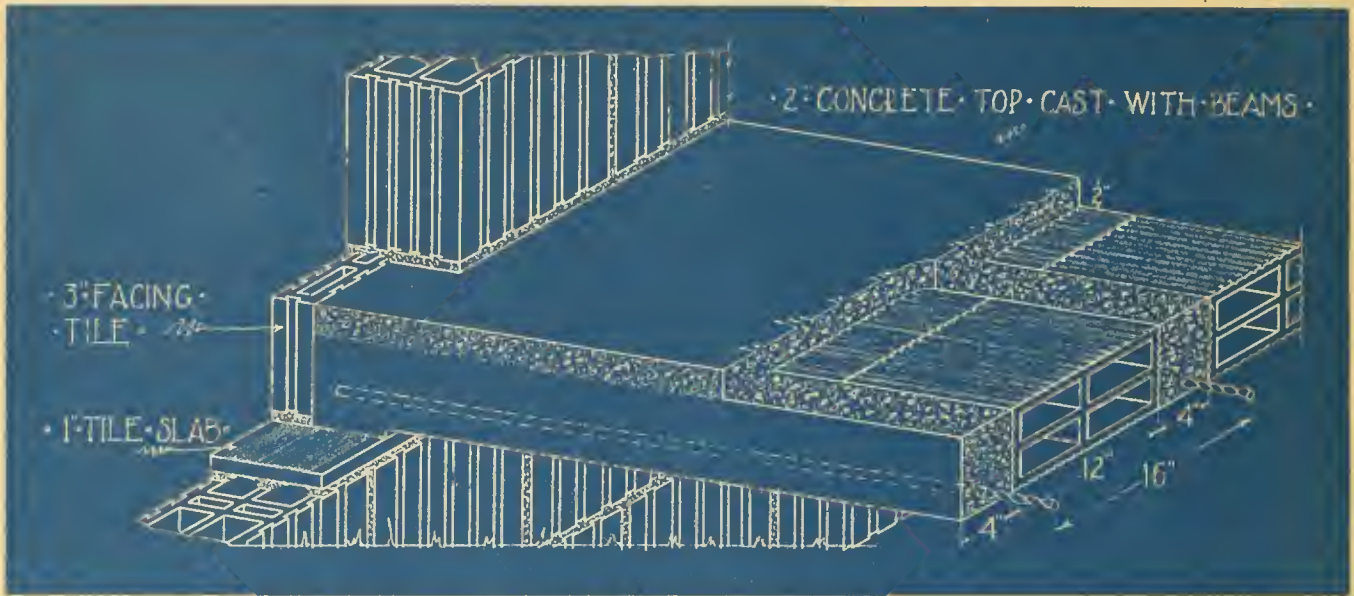
USUAL METHOD OF PLASTERING DIRECTLY ON TILE

• METHOD • OF • BONDING • BRICK • PIER • OR • CHIMNEY • IN • TILE • WALLS



COMBINATION FLOOR

Natco Hollow Tile Combined with Reinforced Concrete Joists, with 2 Inch Concrete Top



EXPLANATORY DATA—Concerning Load Table on page 29.

The upper figures in table denote the depth of tile; the lower figures indicate the area of reinforcing steel required in each concrete joist. The table is so arranged that it can be used for floor slabs freely supported at both ends, semi-continuous or continuous.

For slabs freely supported at both ends (simple span) use loads given opposite $\frac{WL}{8}$.

For slabs freely supported at one end and continuous at other end (semi-continuous span) use loads given opposite $\frac{WL}{9}$.

For slabs continuous at both ends use loads given opposite $\frac{WL}{10}$.

The loads for $\frac{WL}{12}$ are also given, as $\frac{WL}{12}$ is permitted by some building codes for continuous spans.

For semi-continuous and continuous spans proper reinforcement must be provided in top of slab over supports to take care of negative bending moment.

Where heavy loads and short spans are encountered, the vertical and longitudinal shear must be investigated.

The load table is for general information only as each particular operation should be designed in accordance with actual conditions.

Our Engineering Department is at the entire disposal of anyone desiring further information.

AREAS AND WEIGHTS OF BARS

SQUARE BARS

Size in Inches.....	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
Net Area in Sq. In.....	.06	.14	.25	.39	.56	.76	1	1.26	1.56
Weight per Ft. in Lbs..	.21	.48	.85	1.33	1.91	2.60	3.40	4.30	5.31

ROUND BARS

Size in Inches.....	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
Net Area in Sq. In.....	.05	.11	.20	.31	.44	.60	.78	.99	1.23
Weight per Ft. in Lbs..	.17	.38	.67	1.01	1.50	2.04	2.67	3.38	4.17

WEIGHT OF COMBINATION SLABS PER SQUARE FOOT.

Tile.....	3"	4"	5"	6"	7"	8"	9"	10"	12"	15"
Weight	45 lbs.	50 lbs.	55 lbs.	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.	90 lbs.	105 lbs.

COMBINATION FLOOR

TABLE OF TOTAL SAFE LOADS

(dead and live) per square foot for Natco Hollow Tile Floors Combined
with Reinforced Concrete Joists and 2 inch Concrete Top

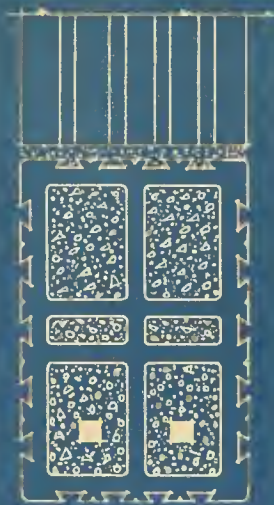
fc. 650 pounds per square inch.
fs. 16000 pounds per square inch.

$$\frac{E_c}{E_s} = \frac{1}{15}$$

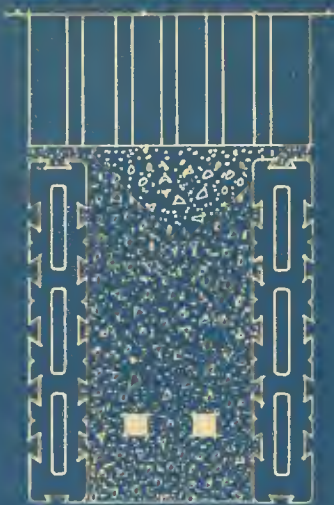
$\frac{3}{4}$ " of concrete below reinforcement.
4" concrete joists 16" o.c.

Total Load	$\frac{W L}{12}$	150	165	180	195	210	225	240	260	300	335	375	450
	$\frac{W L}{10}$	125	135	150	160	175	185	200	220	250	280	310	375
	$\frac{W L}{9}$	110	120	135	145	155	170	180	195	225	250	280	335
	$\frac{W L}{8}$	100	110	120	130	140	150	160	175	200	225	250	300
Span 6'-0"							$\frac{3}{.19}$	$\frac{3}{.20}$	$\frac{3}{.22}$	$\frac{3}{.26}$	$\frac{3}{.29}$	$\frac{3}{.32}$	$\frac{3}{.39}$
" 7'-0"			$\frac{3}{.19}$	$\frac{3}{.21}$	$\frac{3}{.23}$	$\frac{3}{.24}$	$\frac{3}{.26}$	$\frac{3}{.28}$	$\frac{3}{.32}$	$\frac{3}{.35}$	$\frac{3}{.38}$	$\frac{3}{.44}$	$\frac{4}{.42}$
" 8'-0"	$\frac{3}{.23}$	$\frac{3}{.25}$	$\frac{3}{.27}$	$\frac{3}{.30}$	$\frac{3}{.32}$	$\frac{3}{.34}$	$\frac{3}{.37}$	$\frac{3}{.40}$	$\frac{3}{.46}$	$\frac{4}{.41}$	$\frac{4}{.46}$	$\frac{4}{.55}$	
" 9'-0"	$\frac{3}{.29}$	$\frac{3}{.32}$	$\frac{3}{.35}$	$\frac{3}{.37}$	$\frac{3}{.39}$	$\frac{3}{.41}$	$\frac{3}{.43}$	$\frac{4}{.40}$	$\frac{4}{.46}$	$\frac{4}{.52}$	$\frac{4}{.58}$	$\frac{5}{.57}$	
" 10'-0"	$\frac{3}{.36}$	$\frac{3}{.39}$	$\frac{3}{.43}$	$\frac{3}{.46}$	$\frac{4}{.40}$	$\frac{4}{.43}$	$\frac{4}{.46}$	$\frac{4}{.50}$	$\frac{4}{.57}$	$\frac{5}{.53}$	$\frac{5}{.59}$	$\frac{5}{.71}$	
" 11'-0"	$\frac{3}{.43}$	$\frac{3}{.47}$	$\frac{4}{.42}$	$\frac{4}{.45}$	$\frac{4}{.48}$	$\frac{4}{.52}$	$\frac{4}{.55}$	$\frac{4}{.61}$	$\frac{5}{.57}$	$\frac{5}{.64}$	$\frac{5}{.72}$	$\frac{6}{.73}$	
" 12'-0"	$\frac{4}{.41}$	$\frac{4}{.45}$	$\frac{4}{.49}$	$\frac{4}{.53}$	$\frac{4}{.58}$	$\frac{5}{.51}$	$\frac{5}{.55}$	$\frac{5}{.60}$	$\frac{5}{.68}$	$\frac{6}{.65}$	$\frac{6}{.72}$	$\frac{7}{.78}$	
" 13'-0"	$\frac{4}{.48}$	$\frac{4}{.53}$	$\frac{4}{.58}$	$\frac{5}{.52}$	$\frac{5}{.56}$	$\frac{5}{.60}$	$\frac{5}{.64}$	$\frac{5}{.70}$	$\frac{6}{.68}$	$\frac{6}{.77}$	$\frac{7}{.76}$	$\frac{8}{.80}$	
" 14'-0"	$\frac{4}{.56}$	$\frac{5}{.51}$	$\frac{5}{.56}$	$\frac{5}{.60}$	$\frac{5}{.65}$	$\frac{5}{.69}$	$\frac{6}{.63}$	$\frac{6}{.69}$	$\frac{6}{.79}$	$\frac{7}{.79}$	$\frac{8}{.78}$	$\frac{9}{.85}$	
" 15'-0"	$\frac{5}{.53}$	$\frac{5}{.58}$	$\frac{5}{.64}$	$\frac{5}{.69}$	$\frac{6}{.63}$	$\frac{6}{.68}$	$\frac{6}{.72}$	$\frac{6}{.79}$	$\frac{7}{.81}$	$\frac{8}{.81}$	$\frac{8}{.89}$	$\frac{10}{.88}$	
" 16'-0"	$\frac{5}{.60}$	$\frac{5}{.68}$	$\frac{5}{.72}$	$\frac{6}{.67}$	$\frac{6}{.72}$	$\frac{6}{.77}$	$\frac{7}{.74}$	$\frac{7}{.81}$	$\frac{8}{.81}$	$\frac{9}{.84}$	$\frac{9}{.93}$	$\frac{12}{.83}$	
" 17'-0"	$\frac{5}{.68}$	$\frac{6}{.64}$	$\frac{6}{.70}$	$\frac{6}{.75}$	$\frac{6}{.81}$	$\frac{7}{.78}$	$\frac{7}{.83}$	$\frac{8}{.80}$	$\frac{9}{.84}$	$\frac{10}{.84}$	$\frac{10}{.94}$	$\frac{12}{.93}$	
" 18'-0"	$\frac{6}{.65}$	$\frac{6}{.72}$	$\frac{6}{.78}$	$\frac{7}{.76}$	$\frac{7}{.82}$	$\frac{8}{.77}$	$\frac{8}{.82}$	$\frac{8}{.90}$	$\frac{9}{.94}$	$\frac{10}{.95}$	$\frac{12}{.87}$	$\frac{15}{.83}$	
" 19'-0"	$\frac{6}{.73}$	$\frac{6}{.80}$	$\frac{7}{.78}$	$\frac{7}{.84}$	$\frac{8}{.80}$	$\frac{8}{.86}$	$\frac{9}{.84}$	$\frac{9}{.92}$	$\frac{10}{.95}$	$\frac{12}{.87}$	$\frac{12}{.97}$	$\frac{15}{.93}$	
" 20'-0"	$\frac{6}{.81}$	$\frac{7}{.79}$	$\frac{8}{.76}$	$\frac{8}{.82}$	$\frac{8}{.89}$	$\frac{9}{.87}$	$\frac{9}{.93}$	$\frac{10}{.91}$	$\frac{12}{.86}$	$\frac{12}{.97}$	$\frac{15}{.86}$	$\frac{15}{1.03}$	
" 21'-0"	$\frac{7}{.79}$	$\frac{8}{.77}$	$\frac{8}{.85}$	$\frac{8}{.91}$	$\frac{9}{.89}$	$\frac{10}{.86}$	$\frac{10}{.92}$	$\frac{12}{.83}$	$\frac{12}{.95}$	$\frac{15}{.85}$	$\frac{15}{.94}$		
" 22'-0"	$\frac{8}{.77}$	$\frac{8}{.84}$	$\frac{9}{.84}$	$\frac{9}{.91}$	$\frac{10}{.88}$	$\frac{10}{.94}$	$\frac{12}{.83}$	$\frac{12}{.91}$	$\frac{15}{.83}$	$\frac{15}{.93}$	$\frac{15}{1.04}$		
" 23'-0"	$\frac{8}{.84}$	$\frac{9}{.84}$	$\frac{9}{.91}$	$\frac{10}{.89}$	$\frac{10}{.96}$	$\frac{12}{.85}$	$\frac{12}{.91}$	$\frac{12}{.99}$	$\frac{15}{.90}$	$\frac{15}{1.02}$			
" 24'-0"	$\frac{9}{.84}$	$\frac{9}{.92}$	$\frac{10}{.90}$	$\frac{12}{.80}$	$\frac{12}{.87}$	$\frac{12}{.93}$	$\frac{12}{.99}$	$\frac{15}{.87}$	$\frac{15}{.99}$				
" 25'-0"	$\frac{9}{.91}$	$\frac{10}{.89}$	$\frac{12}{.81}$	$\frac{12}{.87}$	$\frac{12}{.94}$	$\frac{12}{1.0}$	$\frac{15}{.86}$	$\frac{15}{.94}$	$\frac{15}{1.07}$				

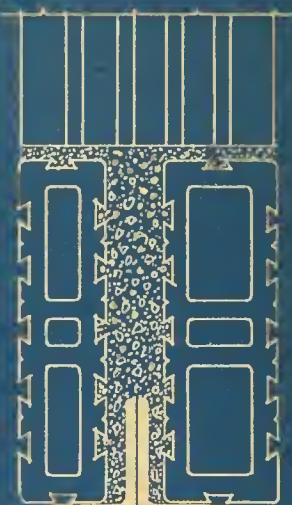
LINTEL SECTIONS.



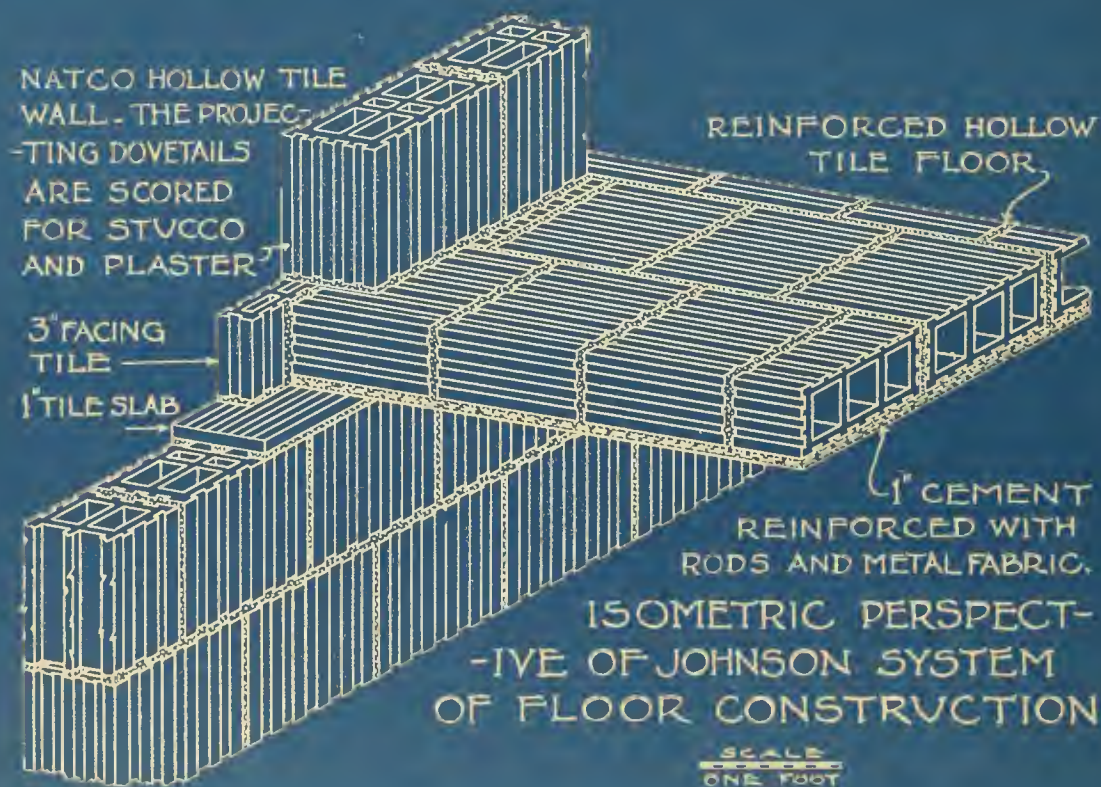
· STOCK TILE
REINFORCED ·



CONCRETE BEAM
FACED WITH 2" TILE



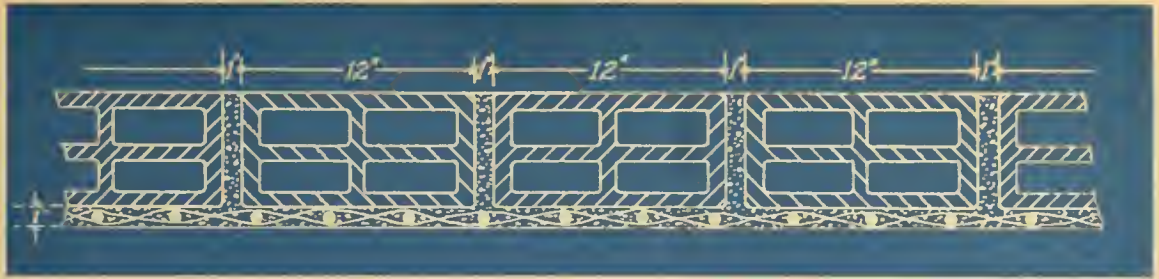
· STOCK 3"X24" TILE ·
· LINTEL WITH ANGLES ·



JOHNSON SYSTEM FLOOR—Load Tables

Without
Concrete
Top

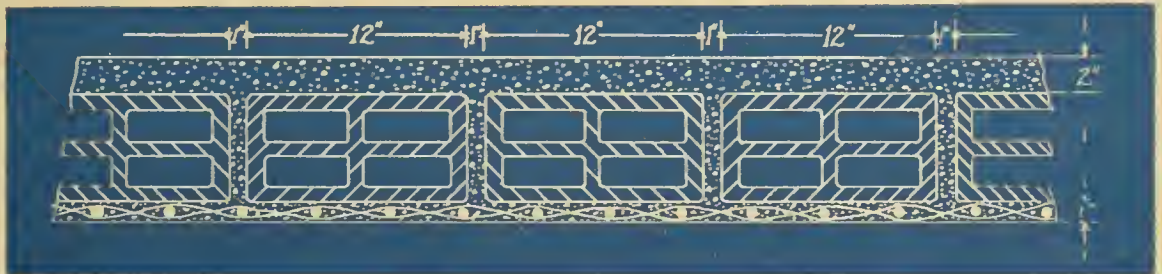
Safe Live
Load in
Pounds per
Square
Foot—
Factor of
Safety, 4.



Area Reinforcing Steel per foot of width Span in Feet	12-in. Tile.	10-in. Tile.	9-in. Tile.	8-in. Tile.	7-in. Tile.	6-in. Tile.	5-in. Tile.	4-in. Tile.	3-in. Tile.
	.64 sq. in.	.57 sq. in.	.51 sq. in.	.47 sq. in.	.42 sq. in.	.38 sq. in.	.31 sq. in.	.25 sq. in.	.22 sq. in.
	Weight of Floor per sq. ft., 55 lbs.	Weight of Floor per sq. ft., 52 lbs.	Weight of Floor per sq. ft., 48 lbs.	Weight of Floor per sq. ft., 45 lbs.	Weight of Floor per sq. ft., 42 lbs.	Weight of Floor per sq. ft., 37 lbs.	Weight of Floor per sq. ft., 35 lbs.	Weight of Floor per sq. ft., 29 lbs.	Weight of Floor per sq. ft., 27 lbs.
5	...	...	...	...	...	...	446	353	213
6	...	...	...	...	579	470	311	227	147
7	...	...	...	553	425	341	223	165	113
8	...	...	488	422	324	263	171	125	79
9	...	507	383	333	254	206	132	113	61
10	558	407	308	264	202	163	105	76	48
11	458	337	253	219	165	133	86	62	
12	386	282	210	179	137	111	71	51	
13	326	234	178	152	116	93	59		
14	278	202	152	129	98	78	49		
15	241	175	130	111	84	68	42		
16	210	151	113	97	73	58			
17	189	133	99	85	63	51			
18	164	117	87	72	56	45			
19	146	103	77	66	49				
20	129	92	68	58	43				
21	117	83	61	51					
22	104	75	54	46					
23	95	67	49						
24	86	61	44						
25	77	55							

With 2 inch
Concrete
Top

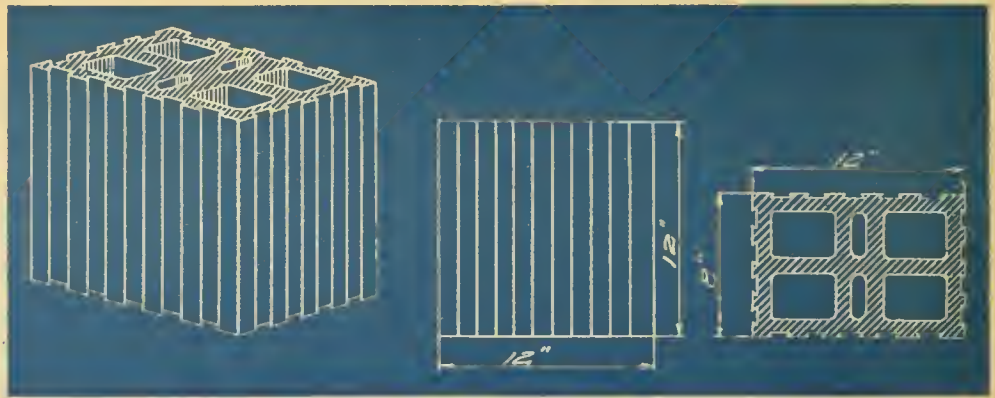
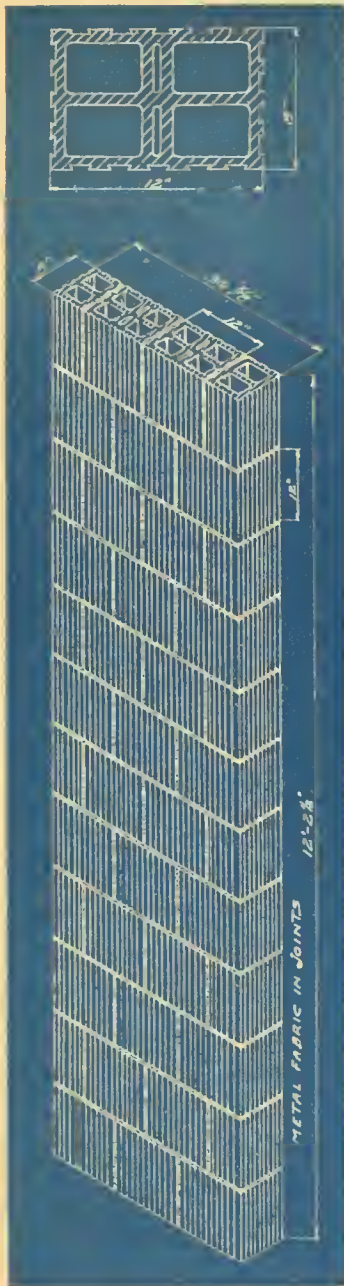
Safe Live Load
in Pounds per
quare Foot—
Factor of
Safety, 4.



Area Reinforcing Steel per foot of width Span in Feet	12-in. Tile.	10-in. Tile.	9-in. Tile.	8-in. Tile.	7-in. Tile.	6-in. Tile.	5-in. Tile.	4-in. Tile.	3-in. Tile.
	1.0 sq. in.	.95 sq. in.	.90 sq. in.	.86 sq. in.	.82 sq. in.	.73 sq. in.	.68 sq. in.	.68 sq. in.	.6 sq. in.
	Weight of Floor per sq. ft., 79 lbs.	Weight of Floor per sq. ft., 77 lbs.	Weight of Floor per sq. ft., 72 lbs.	Weight of Floor per sq. ft., 69 lbs.	Weight of Floor per sq. ft., 66 lbs.	Weight of Floor per sq. ft., 62 lbs.	Weight of Floor per sq. ft., 59 lbs.	Weight of Floor per sq. ft., 54 lbs.	Weight of Floor per sq. ft., 51 lbs.
7	...	...	...	...	...	...	...	...	569
8	...	...	...	...	...	...	...	567	437
9	...	...	...	...	...	...	568	442	342
10	...	...	...	...	...	530	435	354	272
11	...	...	...	...	514	435	355	292	224
12	...	...	572	508	429	365	298	242	187
13	...	568	487	428	364	310	255	204	157
14	...	491	417	368	311	265	215	174	
15	540	421	362	318	269	230	185	151	
16	470	368	317	278	236	200	162		
17	415	326	277	243	207	175	142		
18	368	287	245	215	182	155	125		
19	325	251	219	190	161	137			
20	292	228	195	170	146	121			
21	265	206	175	153	129				
22	238	185	160	139	116				
23	218	168	143	125					
24	196	153	130						
25	178	138							

NOTE—Attention is called to the fact that this construction is reinforced in both directions. The reinforcing rods take the direct strains. The transverse strains are taken by a woven metal fabric running lengthwise of the arch and through this fabric the rods are interwoven at intervals of four inches. The above tables are based on stresses not to exceed: 20,000 pounds per square inch in the steel, 800 pounds per square inch in the concrete, 900 pounds per square inch in the tile, and are for general information only, as each particular operation should be designed in accordance with the actual conditions.

TESTS UPON NATCO XXX SINGLE TILE AND WALL SECTION OBSERVED AND CALCULATED RESULTS



AREA IN COMPRESSION 45.56 SQUARE INCHES

Time P. M.	Gauge Reading in Tons 2000 Lbs.	Actual Load on Tile Lbs.	Actual Load in Lbs. per Sq. In. on Net Area of Tile in Compression	Remarks
	1.25	0	0	
3:09	5	7500	165	
3:26 $\frac{1}{2}$	10	17500	384	
3:28 $\frac{1}{2}$	20	37500	823	
3:30 $\frac{1}{2}$	30	57500	1262	
3:32 $\frac{1}{2}$	40	77500	1701	
3:34 $\frac{1}{2}$	50	97500	2140	
3:39 $\frac{1}{2}$	60	117500	2579	
3:44 $\frac{1}{2}$	70	137500	3018	
3:47	75	147500	3238	Very Slight Sound
3:49 $\frac{1}{2}$	80	157500	3457	No Sounds
3:52	85	167500	3677	No Sounds
3:54 $\frac{1}{2}$	90	177500	3896	Very Slight Sound
3:57	95	187500	4116	Distinct Sound
3:59 $\frac{1}{2}$	100	197500	4335	Slight Sounds
4:02	105	207500	4555	Continual Slight Sounds
4:04 $\frac{1}{2}$	110	217500	4774	Continual Slight Sounds
4:07	115	227500	4994	Continual Cracking Sounds
4:09 $\frac{1}{2}$	120	237500	5213	Failure by Crushing

Built May 6, 1914.

Ends trued up with Portland Cement Mortar. Failed at 237500 Lbs. by Crushing

Tested May 18, 1914.

TEST OF WALL SECTION

AREA IN COMPRESSION 140 SQUARE INCHES

Time P. M.	Gauge Read- ing in Tons 2000 Lbs.	Actual Load on Wall Section Lbs.	Actual Load in Lbs. per Sq. In. on Net Area of Tile in Compression	Horizontal Deflec- tion at Center of Section in Inches	Compression of Section in Inches	Remarks
3:20	2	0	0	.000	.000	
3:22	10	16000	114	.000	.000	
3:24	20	36000	254	.000	.005	
3:26	30	56000	400	.000	.005	
3:28	40	76000	543	.010	.007	
3:30	50	96000	685	.010	.009	
3:32	60	116000	828	.010	.012	
3:34	70	136000	972	.020	.018	
3:36	80	156000	1115	.020	.020	
3:38	90	176000	1256	.020	.026	
3:40	100	196000	1400	.025	.030	Slight Sounds
3:42	110	216000	1544	.030	.035	
3:44	120	236000	1685	.030	.040	Slight Sounds
3:46	130	256000	1828	.030	.047	
3:48	140	276000	1970	.030	.051	
3:50	150	296000	2115	.035	.058	
3:52	160	316000	2255	.035	.063	
3:54	170	336000	2400	.040	.070	Slight Sounds
3:56	180	356000	2545	.040	.077	Sounds
3:58	190	376000	2685	.045	.083	Sounds
4:00	200	396000	2830	.045	.089	Sounds
4:02	210	416000	2970	.050	.093	Sounds
4:04	220	436000	3110			Failed

Failed at 436,000 lbs. by crushing of joints and shearing of tile in second and third courses from top of wall.

This wall section was built and tested for the purpose of determining the strength of walls built of Natco XXX hollow tile. Wall was built on April 21, 1914, and was tested on May 19, 1914. Age 28 Days. Test No. 121.

CONSTRUCTION—This wall section is known as A-324. It was built by an experienced brick layer accustomed to this class of work. The wall is 36 $\frac{3}{8}$ inches long, 8 inches thick and 12 feet 2 $\frac{1}{2}$ inches high, and was built up without the use of forms. All tile were dipped in water before being laid and were laid with joints approximately $\frac{1}{8}$ ths of an inch thick. The mortar used was made of Portland cement, hydrated lime and clean sharp beach sand in proportions 1-1-4.

The following material was used:

Thirty 8x12x12 Natco XXX hollow tile; 0.67 cubic foot of hydrated lime;
Twelve 8x6x12 half tile; 2.67 cubic feet of beach sand;
0.67 cubic foot of Owl Portland cement; 0.84 cubic foot of water.

Wall was built by one man in two hours and thirty-five minutes.

Robert M. Kneib



